July 20, 2001

MEMORANDUM FOR: Participants in the Belt-Conveyor Scales Technical Seminar

From: Steven E. Cook
NIST Technical Advisor

Subject: Final Seminar Summary

Attached is the summary of the Belt-Conveyor Scale Technical Seminar. This summary includes the original agenda items, background information, and participant discussions and recommendations.

The participants' recommendation for the National Conference on Weights and Measures (NCWM) Agenda Item 321-1 was sent to the Specifications and Tolerance Committee for their review during the July 2001 NCWM Annual Meeting. The recommendations for the developing agenda items will be sent to the Western Weights and Measures Association for consideration at their conference in August 2001.

Your time and effort helped make this a successful technical seminar. Thank you again for your interest and participation.

Attachment

cc: Louis E. Straub, NCWM Chairman
Ronald D. Murdock, NCWM Chairman-Elect
Clark Cooney, WWMA S&T Committee Chairman
Stephen A. Patoray, NTEP Director
Henry Oppermann, NIST
NTETC Belt-Conveyor Scale Sector
Victor L. Gerber, Wyoming

National Institute of Standards and Technology
Office of Weights and Measures
Belt-Conveyor Scale Technical Seminar
Meeting Summary
May 1-2, 2001, Gaithersburg MD

Agenda Items

Steve Cook, NIST Technical Advisor, started off he seminar with the introductions of the seminar participants. Steve Cook presented a brief overview of NIST & NCWM and Weights and measures Regulation in the United States for the benefit of the participants that were new to the NIST/NCWM procedures and relationships.

Paul Chase, NTETC Belt-Conveyor Scale Sector Chairman, introduced a concept for group to consider. Those who have participated in calibration of conveyor scales get frustrated with time and resources required with the requirements having been in place for a long time. The existing test procedures were written around mechanical belt-conveyor scale technology. With state of the art electronics it may be possible to review some of the old procedure for to see if they are still valid and can be made more efficient.

Old mechanical integrators had to start and stop the belt to perform calibrations. Today's electronics can perform calibrations and zero-load determinations in a few milliseconds. It is possible to do a very good zero-load test in one belt revolution that would last a minute or two rather than 10 minutes.

International recommendations have already been updated to permit the zero-load in a whole number of complete belt revolutions as close as possible to 3-minutes. (See OIML R-50 A.10.1) and material tests with a test load equal to 2 percent of the load totalized in one hour at the maximum flow rate (See OIML R-50 5.1.3.2). NIST Handbook

44 requirements take at least 10-minutes with a totalized load of 1000 scale divisions, or 10-minutes whichever is greater.

There was consensus among the manufacturers that that the zero-load test could be easily and accurately shortened to 2-3 complete belt revolutions.

There were concerns that shortening the material test would compromise the calibration procedure. The starting and stopping of the belt is where the majority of the errors occur. The errors introduced with the starting and stopping of the belt become a greater part of the test run when the time of the test has been reduced.

Paul Chase indicated that with shorter test time, results in smaller test loads. The smaller test loads can be verified with on-site vehicle or hopper scales as opposed to off-site railroad track scales and the problems related to scheduling and coordination the reference scale tests. A shorter test will make it easier to conduct material tests between official tests and will enhance a users ability to maintain the accuracy of the device.

It was noted that the current OIML R-50 recommendations have been in place since the mid 1980's. Australia had adopted these regulations without significant problems. OIML R-50 is a little tougher than NIST Handbook 44 with testing down to a 20% flow rate. Australia also reported that accurate minimum test loads could vary depending upon the installation. This can be due to the belt start/stop effects, but how fast the increase of the flow rate is when starting to load material the belt. The minimum test load would have to be determined by experimenting with different amounts of material (on the initial verification?)

Before any recommendations can be made, data needs to be collected about the zero-load tests and the effects of the start/stop belt effect.

At this point, Paul Chase provided a table to explain what simulated testing would and wouldn't do. The table shows the various ways of testing and lists some of the sources of error and whether or not (yes, no, or probably) the specific method will show the error.

Error Source **Type of Test**	**Weighed Load**	**Chain**	**Weights**	**R-Cal**
Idler spacing change	Y	P	N	N
Idler vertical misalignment	Y	N	N	N
Belt tension changes	Y	N	N	N
Belt tracking different under load	Y	N	N	N
Errors in electronics	Y	Y	Y	Y
Errors in load cell	Y	Y	Y	P

Y = Yes N = No P = Probably

S&T Committee Item 321-1 - UR.2.2.1. (l) Conveyor Installation; Belt Composition and Maintenance

Source: Carryover Item 321-3. (This item originated from the National Type Evaluation Technical Committee Belt Conveyor Scale Sector and first appeared on the Committee's 1999 Agenda as Item 321-3.)
The Committee considered a proposal from the NTETC Belt Conveyor Scale Sector's proposal to amend paragraph UR.2.2.1. (l) Belt Composition and Maintenance to read as follows:

> **UR.2.2. Conveyor Installation. – The design and installation of the conveyor leading to and from the belt-conveyor scale is critical with respect to scale performance. Installation shall be in accordance with the scale manufacturer's instructions and the following:**
>
> **(l) Belt Composition and Maintenance. - Conveyor belting shall be no heavier than is required for normal use. In a loaded or unloaded condition, the belt shall make ~~full~~ continuous contact with the carry roll (center or horizontal portion) of the idlers. Splices shall not cause any undue disturbance in scale operation (see N.3.).**

Discussion: The Committee recognizes that paragraph UR.2.2.1. (l) is intended to address belt composition, not belt alignment. The Committee agreed with comments heard at the 2001 Interim Meeting that at this point the term "continuous" adequately describes the amount of contact the belt must make with the center of the idlers. The Committee requests a review of all belt-conveyor scale issues by the participants in the Belt-Conveyor Scale Technical Seminar scheduled in Spring 2001 at NIST, Gaithersburg, Maryland. The Committee is moving this item forward because they have not heard sufficient opposition to the proposal. However, if there is no consensus by this group and/or further opposition to the proposal the Committee may withdraw this item at the 2001 Annual Meeting.

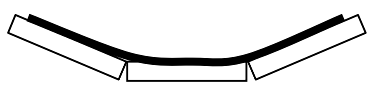


Figure 1

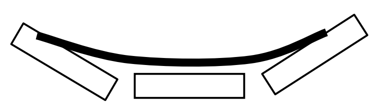


Figure 2

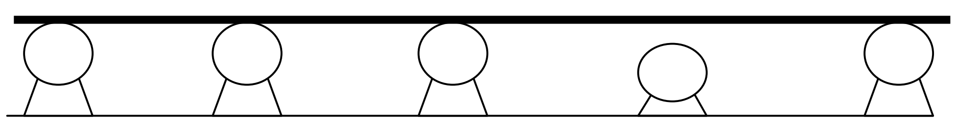


Figure 3

Background: Based on a proposal from the Belt Conveyor Scale Sector, the NCWM voted in 1998 to require the belt in a belt conveyor scale system to make full contact with the carry roll. In October 1999, the Sector submitted that it is difficult to determine if there is full contact with the belt because variations in troughing and temperature make the determination subjective. Therefore, the Sector forwarded the recommendation above to change "full" to "continuous" contact.

During discussions at the 2000 NCWM Interim Meeting, the Committee expressed its concerns that the proposal was unclear about how much of the belt must contact the carry roll. The Committee decided to maintain the item as informational to enable the Sector to clarify the technical concerns about the proposal.

During the 2000 NCWM Annual Meeting, the Committee heard comments that the proposal as written does not address the original problems that can occur because of improper belt thickness. The current proposal might imply that this is a belt alignment requirement because of the reference to multiple idlers. The original intent of the proposal was to ensure that the appropriate belt thickness is maintained at a particular installation. The Committee kept this issue as an information item and asked for input from industry and weights and measures officials to ensure that the proposal addressed all of the original concerns about proper belt thickness. The Committee encouraged the Belt Conveyor Scale Sector to cover this proposal at its next meeting; however, the Sector did not meet in 1999 and 2000 and was not able to develop comments for the S&T Committee.

At its September 2000 meeting, the Western Weights and Measures Association (WWMA) heard comments from a representative of the Southern Companies Services indicating that the issue is more of an alignment problem than a belt composition and thickness issue. The representative indicated that a properly aligned belt would have full contact with all associated weighing idlers under all conditions of ambient temperature. A belt that was too thick would rise off all idlers (not just one) in cold ambient temperatures. The WWMA recognized that belting should have the necessary flexibility to assure contact with all scale area idler rolls when the belt is running empty. After further discussions, the WWMA agreed that modifying paragraph (l) to require full belt contact with the idlers would address the original concerns of the submitter.

The Southern Weights and Measures Association (SWMA) disagreed with the WWMA recommendation to modify the proposal to require the belt make "full" contact with the carry roll idler. The SWMA recommends the NCWM follow the SWMA original recommendation for "continuous" belt contact with the idlers and get input from belt-conveyor scale industry experts on the effects of the proposal.

For additional background, refer to the 1998, 1999, and 2000 S&T Final Reports.

SEMINAR DISCUSSION

There were disagreements about the meaning of the word "full". Some participants felt that "full" applied to the entire conveyor system (figure 3). Others felt that "full" meant the belt had to make contact with 100% of the idlers in the scale area (figure 1) and that "full" contact rarely or never happens. Essentially, the participants felt the wording was ambiguous and subject to interpretation. One manufacture felt that the intent was for the belt to come in contact with the idlers in the scale area and that 2 –3 inches of contact with the center roller of the idler is reasonable. Belt contact with the idlers is a function of belt tension, rigidity in the belt (See Figure 4).

Figure 4

ISO (International Organization for Standardization) 703 puts out a standard for belt troughability (the ability of the belt to lie within the center rollers), which in essence describes what the belt contact should be. When belts are designed to last the thickness is so great that contact is reduced. Contact at the end and center rollers are both to be considered when we talk about longitudinal aligning in the idler trough. The ISO 703 guide addresses belt width to the deflection and that becomes a number. Australia also has a standard for belt troughability. It was noted that steel cable belts trough better than fabric belts. It is hard to determine the troughing of a belt until a belt has been made. Even with the same lot of rubber you can get variations, but belt customers will not change out a new belt to address troughability since the belt is a very costly part of the conveyor system. In the future, a NIST Handbook 44 standard could use a combination of the Australian paper and ISO 703 addressing troughability. It is hard to address contact until belt is fabricated and the belt is the most expensive component.

Manufacturers noted that with troughing depicted in figure 2, you can get a zero reference, but you will have linearity changes.

It was suggested that OIML wording be used because it does not discuss troughability. It simply requires that the full weight of the belt be supported by the scale. Questions were asked if this assures a consistent zero reference at all temperatures and loading conditions. Material will push it down on the belt. If belt tension is too high, some of the weight of the belt will be lifted off the scale. If the tension is correct with the entire weight of the belt supported by the scale, belt loading will have no effect on scale accuracy. A linearity test would be a better way to test for problems with the zero reference due to belt contact with the scale. However, there are no recommendations in NIST Handbook 44 for linearity testing (testing at different feed rates). If testing at different feed rates were to become a requirement, many of the "User Requirements" regarding installation may not be required. The down side is that this would add significant costs to the material tests.

It was noted that Publication 14 states, "Under any load, the belt shall contact the center or horizontal portion of the idlers" (See Section 9.7.13.1). This is similar to the way NIST Handbook 44 was worded several years ago.

SEMINAR RECOMMENDATION

The participants of the Belt-Conveyor Scale Technical Seminar will submit the following recommendation to the S&T Committee that modifies the proposed language similar to the language used in Publication 14. Additionally, add language that further defines the area of the belt-conveyor system that is likely to have an effect on belt-conveyor scale performance.

321-1 – UR.2.2.1. (l) Conveyor Installation: Belt Composition and Maintenance

UR.2.2. Conveyor Installation. – The design and installation of the conveyor leading to and from the belt-conveyor scale is critical with respect to scale performance. Installation shall be in accordance with the scale manufacturer's instructions and the following:

> **(l) Belt Composition and Maintenance. - Conveyor belting shall be no heavier than is required for normal use. In a loaded or unloaded condition, the belt shall make ~~full~~ <u>constant</u> contact with the ~~carry roll (center or~~ horizontal <u>and wing rollers</u> ~~portion)~~ of the idlers <u>in the scale area</u>. Splices shall not cause any undue disturbance in scale operation (see N.3.).**

<u>scale area. The scale area refers to the scale suspension, weigh idlers attached to the scale suspension, 5 approach (-) idlers, and 5 retreat (+) idlers. [2.21]</u>

Appendix D (Item 360-4) Developing Issues – Belt-Conveyor Scale Systems

Item 1 D S.1.4. Recording Elements and Recorded Representations

Source: NIST-OWM and interested NTETC Belt-Conveyor Scale Sector Members. This item originated from the Western Weights and Measures Association (WWMA) and first appeared as Appendix C (Item 360-3) Developing Issues on the Committee's 2000 agenda.

Recommendation: Modify paragraph S.1.4. Recording Elements and Recorded Representations as follows:

> ***S.1.4. Recording Elements and Recorded Representations. - The value of the scale division of the recording element shall be the same as that of the indicating element. The belt-conveyor scale system shall record the initial indication and the final indication of the master weight totalizer*, the quantity delivered*, the unit of measurement (e.g., kilograms, tonnes, pounds, tons, etc.), the date, and time. <u>A zero reference number shall be recorded before and after any complete weighing cycle **</u>. This information shall be recorded for each delivery*.***
> ***[Nonretroactive as of January 1, 1986.]***
> ***[*Nonretroactive as of January 1, 1994.]***
> ***[**Nonretroactive as of January 1, 200X.]***

Background/Discussion: The proposed change is intended to ensure the buyer and seller are informed that a zero condition is established at both the start and end of each transaction. The NCWM S&T Committee discussed that there does not appear to be a mechanism to adequately address belt-conveyor scales systems where the zero change exceeds the allowable range of the zero setting mechanism. The Committee recognizes there are accuracy issues when zero and span move concurrently, but wants industry input about how widespread these inaccuracies are before supporting proposals to change Handbook 44.

SEMINAR DISCUSSION

One of the comments received is that the whether or not the term "number" should be used. The recording of the no-load reference value is also in other NIST Handbook 44 Codes. The printing or recording of a reference <u>value</u> such as "percent" would be better than <u>number</u>. One of the participants noted that a zero <u>number</u> is necessary to track the long term zero stability. The way the proposal is written, the no load value may not have any meaning. The only way to record an actual no-load reference is to record the value after a zero-load test. Printing a zero value, that had been determined several hours before, is of little value. The zero-load test takes time (three revolutions/ 10-minutes) and will not be performed as much as desired.

Additionally, there are extremes in the way product is delivered. For example, vehicle loading requires that the belt starts and stops between each vehicle. Performing a zero load test between each vehicle is impractical.

One suggestion was to add a third statement to the proposal that indicates that the zero has shifted a determined percentage and will be printed by the recording element. Another comment was that the zero reference be recorded and retained by the audit trail. The recording of the zero reference value, along with master weight totalizer resetting information, is a Canadian requirement (Audit trails will be discussed later in the seminar). Percentage values would be more useful in that it requires fewer calculations by the operator and inspectors.

SEMINAR RECOMMENDATION

The participants of the Belt-Conveyor Scale Technical Seminar recommends that the Western Weights and Measures Association (WWMA) amend the proposed item to include the following new specification, user requirement and definitions.

S.1.4. Recording Elements and Recorded Representations. - The value of the scale division of the recording element shall be the same as that of the indicating element. The belt-conveyor scale system shall record the initial indication and the final indication of the master weight totalizer*, the quantity delivered*, the unit of measurement (e.g., kilograms, tonnes, pounds, tons, etc.), the date, and time. This information shall be recorded for each delivery *.
[Nonretroactive as of January 1, 1986.]
[*Nonretroactive as of January 1, 1994.]

S.1.4.X The belt-conveyor scale system shall be capable of recording the results of automatic or semi automatic zero load tests. **
[**Nonretroactive as of January 1, 200X.]

UR.X. When zero load reference information is recorded for a weighing cycle the information must be based upon zero load tests performed both immediately before and immediately after the complete weighing cycle.

DEFINITIONS

zero-load reference. A zero-load reference value represents no load on a moving conveyor belt. This value can be either; a number representing the electronic load cell output, a percentage of full scale capacity, or other reference value the accurately represents the no load condition of a moving conveyor belt. The no load reference value can only be updated after the completion of a zero load test. [2.21]

automatic zero-setting mechanism (belt-conveyor scale). A zero setting device that operates automatically without intervention of the operator after the belt has been running empty. [2.21] *(Consistent with OIML R-50)*

zero-setting mechanism (belt-conveyor scale). A mechanism enabling zero totalization to be obtained over a whole number of belt revolutions [2.21]. *(Consistent with OIML R-50)*

Item 2 D S.3.1. Design of Zero-Setting Mechanism

Source: NIST-OWM and interested NTETC Belt-Conveyor Scale Sector Members. This item originated from the Western Weights and Measures Association (WWMA) and first appeared as Appendix C (Item 360-3) Developing Issues on the Committee's 2000 agenda.

Recommendation: Modify paragraph S.3.1. Design of Zero-Setting Mechanism as follows:

> **S.3.1. Design of Zero-Setting Mechanism. - The range of the zero-setting mechanism shall not be greater than ± 2 percent *(<u>± 5 percent</u> **)* of the rated capacity of the scale without breaking the security means. Automatic ~~and semi-automatic~~ zero-setting mechanisms shall be so constructed that the resetting operation is carried out only after a whole number of belt revolutions and the completion of the setting or the whole operation is indicated.** ***An audio or visual signal shall be given when the automatic ~~and semiautomatic~~ zero-setting mechanisms reach the limit of adjustment of the zero-setting mechanism.****
> ***[*Nonretroactive as of January 1,1990.]***
> ***[**Nonretroactive as of January 1, 200X.]***

Background/Discussion: The proposal retroactively restricts a belt-conveyor scale system's zero-setting mechanism to only automatic means. Some companies have expressed concerns about conflicts with OIML requirements that permit a semiautomatic zero-setting mechanism. Some devices in the marketplace are equipped with only a semiautomatic zero-setting mechanism for adjusting zero.

SEMINAR DISCUSSION

The intent of the proposed agenda item was to permit only automatic zero-setting mechanisms and to expand the zero-setting mechanism to adequately track belt loss or build up of material or other factors that can change the zero reference beyond 2 percent. It was noted the belt wear, by itself, could account for a 1.5 percent zero change in less than six months. Breaking the security means to readjust for zero often requires "Official Material Tests" every six months. Comments were also received that the warning indications that the zero has exceeded that allowable 2 percent are often ignored and/or disabled.

Concerned was raised that allowing for a larger zeroing range would reduce the incentive for proper belt conveyor scale maintenance.

The proposal as written does not prohibit semiautomatic zero-setting mechanisms, but allows for different ranges depending on the type of zero-setting mechanism.

One of the participants suggested that a sliding zero range of 4 percent rather than "± 2 percent" could be considered as a possible solution. Another participant restated that if adequate zero data were available, the operator could make the necessary maintenance and corrections without needing to break the security means. Another suggestion was to allow the zero range to be extended, but retain the requirement for an alarm at the "± 2 percent" range. Additionally, the master weight totalizer could be programmed to not print any tickets if zero exceeded the ± 2 percent. One manufacture noted that the zero reference value is recorded in the audit trail information when the zero range exceeds ± 2 percent.

The seminar participants then discussed a compromise that would permit a system to have a zero range greater than ± 2 percent provided it printed the zero information at the beginning and end of each weighing cycle.

SEMINAR RECOMMENDATION

The participants in the Belt-Conveyor Scale Technical Seminar recommend that the WWMA amend the proposal as follows.

> **S.3.1. Design of Zero-Setting Mechanism. -** ***Except for systems that record the zero load reference at the beginning and end of each weighing cycle,*** **the range of the zero-setting mechanism shall not be greater than ± 2 percent of the rated capacity of the scale without breaking the security means. Automatic and semi-automatic zero-setting mechanisms shall be so constructed that the resetting operation is carried out only after a whole number of belt revolutions and the completion of the setting or the whole operation is indicated.** ***An audio or visual signal shall be given when the automatic and semiautomatic zero-setting mechanisms reach the limit of adjustment of the zero-setting mechanism.****
>
> ***Systems that record the zero load reference at the beginning and end of each weighing cycle, the range of zero-setting mechanism shall not be greater the +/- 5 percent without breaking the security means.***
>
> ***[*Nonretroactive as of January 1,1990.]***
> ***[**Nonretroactive as of January 1, 200X.]***

Item 3 D S.3.2. - Sensitivity at Zero Load (For Type Evaluation)

Source: NIST-OWM and interested NTETC Belt-Conveyor Scale Sector Members. This item originated from the Western Weights and Measures Association (WWMA) and first appeared as Appendix C (Item 360-3) Developing Issues on the Committee's 2000 agenda.

Recommendation: Modify paragraph S.3.2. - Sensitivity at Zero Load (For Type Evaluation) as follows:

> ***Sensitivity at Zero Load (For Type Evaluation). - When a system is operated for a time period equal to the time required to deliver the minimum test load and with a test load calculated to indicate ~~two scale divisions~~ <u>0.12 percent of its rated capacity</u> applied directly to the weighing element, the totalizer shall advance not less than ~~one~~ <u>0.06 percent of its rated capacity</u> or more than ~~three scale divisions~~ <u>0.18 percent of its rated capacity</u>. An alternative test of equivalent sensitivity, as specified by the manufacturer, shall also be acceptable. [Nonretroactive as of January 1, 1986.]***

Background/Discussion: The proposal is intended to specify tolerances as percentage values, rather than scale division values. The WWMA asked industry for comments about the proposed tolerances. The NCWM S&T Committee heard concern from an industry representative that there may be some confusion when the operator must determine percentages. The Committee briefly discussed the appropriateness of basing sensitivity tolerances on division size rather than the rated capacity of a dynamic system.

SEMINAR DISCUSSION

The proposal as written, changes the value of the requirements from scale divisions to percentages.

Comments were received that percentages are easier to understand and that the scale division is not related to the scale resolution. Alternatively, by basing the tolerance on the number of divisions is easier to determine. Some participants commented that this is a totalizer issue and that tolerance should be in ***divisions***. From a regulatory standpoint, applying tolerances in totalizer ***divisions*** is easier and removes the potential or errors in the calculating (and rounding) of percentages.

Paul Chase indicated that three divisions roughly equals 0.18 percent for scales that have a minimum increment that is 1/1500 of the rated capacity of the scale. One of the reasons to express the tolerance as a percentage is to prevent someone from using a large division size and making the sensitivity test less stringent. However, it should be noted that NIST Handbook 44 states that the value of the scale division shall be not greater than 1/1000 of the rated capacity of the device (See NIST Handbook 44 Section 2.21. S.1.3.1.). With the sensitivity test tolerance stated as a specific number of divisions, the division size will be representative of the sensitivity of the scale, even with scales that have a high resolution.

SEMINAR RECOMMENDATION

The Participants on the Belt-Conveyor Scale Technical Seminar feel that the values for the sensitivity requirements should remain in terms of scale divisions rather than percentages. The seminar participants recommend that the Western Weights and Measures Association withdraw 360-4 Developing Item 4 from their agenda.

Item 4 D N.3.1. Zero Load Tests

Source: NIST-OWM and interested NTETC Belt-Conveyor Scale Sector Members. This item originated from the Western Weights and Measures Association (WWMA) and first appeared as Appendix C (Item 360-3) Developing Issues on the Committee's 2000 agenda.

Recommendation: Modify paragraph N.3.1. Zero Load Tests as follows:

> **N.3.1. Zero Load Tests. – If a belt-conveyor scale system has been idle for a period of two hours or more, the system shall be run for not less than 30 minutes when the temperature is above 5 °C (41 °F). When the temperature is below 5 °C (41 °F), additional warm-up time, depending upon conditions, is required before beginning the zero-load tests. The variation between the beginning and ending indication of the master weight totalizer shall not exceed ~~be more than □1 scale division~~ □0.06 percent of the rated capacity when the ~~instrument~~ automatic zero-setting mechanism is operated at no load for a period of time equivalent to that required to deliver the minimum totalized load of 1000 scale divisions.**
>
> **The zero-load test shall be conducted over a whole number of belt revolutions, but not less than three revolutions or 10 minutes operation, whichever is greater.**
>
> **During any portion of the zero-load test, ~~the~~ any change in the totalizer reading shall not ~~change more than three scale divisions~~ exceed a range of 0.18 percent of its rated capacity from its initial indication**
> **(Amended 1989)**

Background/Discussion: The proposal is intended to provide a better statistical method of determining a belt-conveyor scale system's sensitivity by expressing it as a percent of the rated capacity. The zero is established based on the automatic zero-setting mechanism, and that zero is adequately monitored.

SEMINAR DISCUSSION

The proposal as written, changes the value of the requirements from scale divisions to percentages. The same arguments of scale division vs. percentage of scale capacity discussed in developmental item 3 also apply.

Participants indicated concerns with the existing temperatures and changes in temperatures that were not part of this proposal. There was confusion that this requirement was a temperature stability test that required maintenance of zero over time. OIML R-50 recommends that the zero reference be verified (a zero-load test conducted) for every 10 degree C change in the ambient temperature. It was clarified that the paragraph is intended as a test note for the inspector on how long to "warm up" the belt before conducting the zero-load test and not a test of zero stability during temperature changes. This amount of "warm-up" is intended to help ensure a valid zero reference determination and test.

It was noted that the participants were dealing with two different issues. One is that the inspector wants to make sure that variables are not introduced into the test procedures that would affect the results. The other is that this may not reflect the real world the device is being used. Device performance over a temperature change is determined during type evaluation of the load cell, weighing element and integrator. Laboratory type evaluation is unable to dynamically test for belt effects due to temperature changes.

In the early part of the seminar, Paul Chase introduced the concept of conducting the zero load tests for a shorter period of time. Current technology can accurately determine and compensate for the weight of the empty belt in one revolution of the belt. The zero reference during the one revolution will likely go up and down depending on the misalignment or whether the belt is cold or hot. The integrator electronics can balance out and average these variations in one belt revolution. If the zero-load test can be shortened to 1-2 minutes, it would be feasible to run three successive tests that repeat within a certain percentage and eliminate the belt "warm-up" concerns from the test procedure.

SEMINAR RECOMMENDATION

The Participants on the Belt-Conveyor Scale Technical Seminar feel that the values in terms of scale divisions rather than percentages. The seminar participants recommend that the Western Weights and Measures Association withdraw 360-4 Developmental Issues-Belt-Conveyor Scale Systems Item 4 from their agenda.

A new proposal will be developed based upon the concept that an abbreviated zero load test is being considered based upon a whole number of revolutions, no less than one minute. The intent would be to have 3 abbreviated zero-load tests to agree within some limits (ex: 0.06%) (See Seminar Recommendations for Developmental Issues-Belt-Conveyor Scale Systems Item 6).

Item 5 D N.3.2. Material Tests

Source: NIST-OWM and interested NTETC Belt-Conveyor Scale Sector Members. This item originated from the Western Weights and Measures Association (WWMA) and first appeared as Appendix C (Item 360-3) Developing Issues on the Committee's 2000 agenda.

Recommendation: Modify paragraph N.3.2. Material Tests as follows:

> **N.3.2. Material Tests.**
>
> **(g) On initial verification, at least three individual <u>materials</u> tests shall be conducted.**
>
> **On subsequent verifications, at least two individual <u>materials</u> tests shall be conducted. The performance of the equipment is not to be determined by averaging the results of the individual tests <u>when one or more sources of material or top-size is used in the weighing process</u>. The results of all these <u>materials</u> tests shall be within the tolerance limits.**

Background/Discussion: The proposal is intended to require test of a belt-conveyor scale "as used" when there is more than one source or size of material for the material test. The proposal clarifies that the material test results must not be averaged when there are multiple sources and sizes of material. In its review of the proposed changes the WWMA commented that the repeated use of the term "material test" is unnecessary and that the term "top size" is confusing and requires defining.

SEMINAR DISCUSSION

The discussion initial centered on the meaning of the terms "sources of material or top-size". Material feed points on a scale are important to consider, but is different from "source of material. You could have material coming from two or more locations, but loaded from the same feed chute on to the belt. Separating the 'load points" from the "types of materials" into different paragraphs was considered

It was agreed that different materials react differently when loaded on to the belt, including different sized materials. Changes occur in the product flow rate, the effect of the product "free fall", and even the direction the product goes across the scale. One jurisdiction noted that they are not able to test the entire range of products at some installations, but do test what they consider to be representative of all the materials.

It was also noted that the way the proposed amendment is written, results could actually be averaged if the installation did not have different materials or feed locations. Additionally, the wording in the original paragraph could be interpreted that averaging of test results is permitted during the initial verification and not during subsequent evaluations.

SEMINAR RECOMMENDATION

The Participants on the Belt-Conveyor Scale Technical Seminar agreed that a list of examples of the different "conditions of installation" could be included in the Notes section of the belt conveyor code. Additionally, the existing language could be reorganized to clarify that all test results shall be within the tolerance limits for all official tests and that no test results can be averaged.

The participants recommend the following amendments to the Notes paragraphs of section 2.21 Belt-Conveyor Scale Code:

N. Notes

N.1. General. – Belt-conveyor scales are capable of weighing bulk materials accurately. (See Tolerances.) However, their performance can be detrimentally affected by the conditions of the installation. (See User Requirements.) The performance of the equipment is not to be determined by averaging the results of the individual tests. The results of all tests shall be within the tolerance limits.

N.1.1. Official Test.

N.1.1 - An official test of a belt-conveyor scale system shall be a materials test.

N.1.2. Simulated Test. . . .

N.2. Conditions of Tests. - . . .

N.3. Test Procedures

N.3.1. Zero Load Tests. . . .

N.3.2. Material Tests. Material tests should be conducted using any or all actual belt loading conditions. These belt loading conditions shall include but are not limited to conducting materials tests using different belt loading points, all types and sizes of products weighed on the scale, at least one other belt speed, and in both directions of weighing.

On initial verification, at least three individual tests shall be conducted. On subsequent verifications, at least two individual tests shall be conducted. The results of all these tests shall be within the tolerance limits.

~~Use bulk material, preferably that material for which the device is normally used.~~ Either pass a quantity of pre-weighed material over the belt-conveyor scale in a manner as similar as feasible to actual loading conditions, or weigh all material that has passed over the belt-conveyor scale. Means for weighing the material test load will depend on the capacity of the belt-conveyor scale for the test and the availability of a suitable scale for the test. To assure that the test load is accurately weighed and determined, the following precautions shall be observed.

(a) The containers, whether railroad cars, trucks or boxes, must not leak, and shall not be overloaded to the point that material will be lost.

(b) The actual empty or tare weight of the containers shall be determined at the time of test. Stenciled tare weight of railway cars or trucks shall not be used. Gross and tare weights shall be determined on the same scale.

(c) When a pre-weighed test load is passed over the scale, the belt loading hopper shall be examined before and after the test to assure the hopper is empty and that only the material of the test load has passed over the scale.

(d) When practicable, a reference scale should be tested within 24 hours preceding the determination of the weight of the test load used for a belt-conveyor scale material test.

A reference scale which is not "as found" within maintenance tolerance should have its accuracy re-verified after the belt-conveyor test with a suitable known weight load if the "as found" error of the belt-conveyor scale materials test exceeds maintenance tolerance values.

(e) If any suitable known weight load other than a certified test weight load is used for reverification of reference scale accuracy, its weight shall be determined on the reference scale after the reference scale certification and before commencing the belt scale material test.

Note: Even if the reference scale is within maintenance tolerance it may require adjusting to be able to meet paragraph N.3.2.1.

(f) The test shall not be conducted if the weight of test load has been affected by environmental conditions.

~~(g) On initial verification, at least three individual tests shall be conducted. On subsequent verifications, at least two individual tests shall be conducted. The performance of the equipment is not to be determined by averaging the results of the individual tests. The results of all these tests shall be within the tolerance limits.~~

N.3.3. Simulated Load Tests. –

(a) . . .
(b) . . .
(c) . . .

Item 6 D T.1.2. Variation in Zero Reference Values

Source: NIST-OWM and interested NTETC Belt-Conveyor Scale Sector Members. This item originated from the Western Weights and Measures Association (WWMA) and first appeared as Appendix C (Item 360-3) Developing Issues on the Committee's 2000 agenda.

Recommendation: Add new paragraph T.1.2. Variation in Zero Reference Values to the Belt-Conveyor Scale Systems Code as follows:

> ***T.1.2. Variation in Zero Reference Values. - Variation in a zero reference number on a conveyor system at no load shall not be greater than ±0.25 percent of the rated capacity of the scale when randomly monitored for 95 percent of the zero measurements in all normal operating conditions over an ambient temperature range of up to 12 ^{0}C (54 ^{0}F) in a 24 hour period.***
> ***[Nonretroactive as of January 1, 2002.]***

Background/Discussion: Environmental factors such as wind, moisture, dust, and temperature, affect a belt-conveyor scale system's zero under no-load condition. The proposal is intended to establish acceptable variations in the zero value over specific temperature intervals.

At its September 2000 Meeting, the WWMA noted that the proposed range does not cover all environmental temperature conditions to which a belt-conveyor scale might be subjected. The WWMA recommended modifying the proposal to express a relationship between tolerances and temperature ranges; it made this item developmental to allow additional time for input on this modification. At the SWMA 2000 Annual Meeting, an industry representative questioned how often belt-conveyor scale operators verify zero at most installations.

During the 2001 NCWM Interim meeting, NIST-OWM and a member of the NTETC Belt-Conveyor Scale Sector provided the S&T Committee with an update on activities related to the Belt-Conveyor Scale Systems Developing Items on the Committee's agenda. They reported developing alternate language for Items 1 through 9 to better clarify the intent of each item and asked that the Committee replace the existing recommendations with the revised language. The revised language shown above replaces the original proposal in the recommendation.

> ***T.1.2. Variation in Zero Reference Values. - Variation in a zero reference number on a conveyor system at no load shall not be greater than ±0.25 percent of the rated capacity of the scale when randomly monitored for 95 percent of the zero measurements in all normal operating conditions over an ambient temperature range of up to 12 ^{0}C (54 ^{0}F) in a 24 hour period.***
> ***[Nonretroactive as of January 1, 2002.]***

SEMINAR DISCUSSION

The submitter discussed the intent of the proposal as a way of ensuring zero stability over a range of temperatures and provides a level of assurance that zeroing and maintenance practices practices are good. The monitoring of zero and temperature can be automated by computer and reviewed by weights and measures officials and other interested parties to the weighing of bulk products. A weights and measures official would be able to review the records to determine compliance.

It was noted that this proposal, by itself, does not require that the zero (and temperature) information be recorded. This proposal was intended to be used in conjunction with developing item 1, which required that the zero reference value be recorded before and after each weighing cycle. The seminar participants have previously recommended that developing item 1 be amended which removed this requirement.

The discussion included concerns on the number of zero reference values and the impact of available memory in an audit trail, the variations in the number of complete weighing cycles (depending on the installation) and may need to be recorded on a separate device.

It was suggested that the requirement for monitoring zero be rewritten as a user requirement that included periodic zero-load testing and record keeping similar to the User Requirement for simulated load or unofficial material tests [See current UR.3.2. (b.) and (e)]. After further consideration, it was suggested that zero stability procedures be included in the test notes and that used requirements include the requirement that the user perform zero load test at periodic intervals and record the information.

SEMINAR RECOMMENDATION

The Participants on the Belt-Conveyor Scale Technical Seminar recommend that the WWMA withdraw Developmental Issues -Belt-Conveyor Scale Systems Item 6.

Additionally, the WWMA may want to consider the following alternative wording for N.3. The proposed language is designed to address the issues of zero stability, variations in the zero reference value, zero-load test repeatability and shorten the time for the conduct of the zero-load test.

It should be noted that the value of 0.12 percent in paragraph N.3.1.3. is based on an allowance for 0.06 percent random variableness in the system and 0.06 percent temperature shift and is equivalent to 0.06 % per 5 °C hence 0.012 %/ 1 °C. The stability criteria will limit the in service zero error to 0.24 percent over a 20 °C change in temperature.

The test described in N.3.1.4 addresses the third paragraph of the previously proposed new wording for N.3.1 (and the OIML in-situ test 2.6.4) for Maximum Variation during zero-load test.

N.3. Test Procedures.

N.3.1. Zero Load Tests. - ~~**If a belt-conveyor scale system has been idle for a period of 2 hours or more, the system shall be run for not less than 30 minutes when the temperature is above 5 °C (41 °F). When the temperature is below 5 °C (41 °F), additional warmup time, depending upon conditions, is required before beginning the zero-load tests. The variation between the beginning and ending indication of the master weight totalizer shall not be more than ± 1 scale division when the instrument is operated at no load for a period of time equivalent to that required to deliver the minimum totalized load of 1000 scale divisions.**~~

~~**The zero-load test shall be conducted over a whole number of belt revolutions, but not less than three revolutions or 10 minutes' operation, whichever is greater.**~~

~~**During any portion of the zero-load test, the totalizer shall not change more than three scale divisions from its initial indication.**~~
~~**(Amended 1989)**~~

<u>**A Zero-Load Test shall be conducted to establish that the belt scale system (including the conveyor) is capable of holding a stable, in service zero.**</u>

<u>**N.3.1.1 A "Zero-Load Test" is a determination of the error in zero, expressed as a percentage of full scale capacity, internal reference, or a change in a totalized load over a whole number of complete belt revolutions and over a period of at least one (1) minute.**</u>

<u>**N.3.1.2 Initial Stable Zero. The conveyor system shall be run to warm up the belt and the belt scale shall be zero adjusted as required. A series of zero-load tests shall be carried out until three consecutive zero-load tests each indicate an error, which does not exceed +/-**</u>

0.06% of full-scale capacity. No adjustments can be made during the three consecutive zero-load test readings.

N.3.1.3 Test of Zero Stability. The conveyor system shall be run to warm up the belt and the belt scale shall be zero adjusted as required.

A series of zero load tests shall be carried out immediately before the simulated or materials test, until three consecutive zero load tests each indicate an error, which does not exceed +/- 0.06% of full-scale capacity. No adjustments can be made during the three consecutive zero-load test readings.

Immediately after material has been weighed over the belt-conveyor scale during the conduct of he materials test, the zero-load test shall be repeated. The zero error from this test shall not exceed +/-0.12% of full-scale capacity.

After a period of not less than four hours or a temperature change of not less than 5 degrees Celsius, a father zero load test shall be carried out. The time and temperature shall be recorded at the start and end of the test period. The zero error from this test shall not exceed +/- 0.12% of full-scale capacity [0.024% of full scale capacity per degree Celsius].

N.3.1.4 Check for adequate consistency of conveyor belt weight along its entire length. During any portion of a zero load test which records a zero error of +/- 0.06% or better, the flow rate shall be observed to ensure that no flow rate in excess of + 0.18% or less than - 0.18% of full scale capacity occurs. During this test, any flow rate filtering shall be effectively disabled.

Item 7 D UR.2.2. Conveyor Installation (a) and (b)

Source: NIST-OWM and interested NTETC Belt-Conveyor Scale Sector Members. This item originated from the Western Weights and Measures Association (WWMA) and first appeared as Appendix C (Item 360-3) Developing Issues on the Committee's 2000 agenda.

Recommendation: Modify paragraphs UR.2.2. (a) and (b) Conveyor Installation as follows:

> **UR.2.2. Conveyor Installation. - The design and installation of the conveyor leading to and from the belt-conveyor scale is critical with respect to scale performance. The conveyor may be horizontal or inclined but, if inclined, the angle shall be such that slippage of material along the belt does not occur. <u>The belt-conveyor shall be protected from any precipitation.</u> Installation shall be in accordance with the scale manufacturer's instructions and the following:**
>
> **(a) Installation General. - A belt-conveyor scale <u>structure</u> shall be so installed that neither its performance nor operation will be adversely affected by any characteristic of the <u>weighed material</u>, foundation, supports, <u>covers (when present),</u> or any other equipment.**
>
> **(b) Live Portions of Scale. - All live portions of the <u>conveyor</u> scale <u>structure</u> shall be protected by appropriate guard devices<u>. On incline belt-conveyors, scale structure and surrounding supports shall have a minimum clearance of 10 percent above the top-size of the material (but not to exceed 3 inches)</u> to prevent accidental interference with the weighing operation.**

Background/Discussion: The proposal is intended to prevent belt-conveyor scales in a "no load" condition from indicating an incorrect zero when environmental or physical factors that adversely affect the system occur.

At its September 1999 Meeting, the WWMA recognized that pending 2000 NCWM action on S&T Agenda Item 321-2 UR.2.2. Conveyor Installation and UR.2.2.1 For Scales not Installed by the Manufacturer (1999 Carryover Item 321-2) could affect this proposal. Therefore, the WWMA recommended this proposal be given developmental status. At the October 1999 SWMA Annual Meeting, an industry representative expressed concern with the cost of protecting an entire belt from environmental factors.

SEMINAR DISCUSSION

As an update to the background information listed in this developing item, the 2000 NCWM Conference Report indicated that S&T Agenda Item 321-2 UR.2.2. Conveyor Installation and UR.2.2.1 was adopted. This item addressed installation requirements and noted that there should be no differences in installation between scales installed by the manufacturer and scales not installed by the manufacturer. No additional language was considered for that item which addressed protection from environmental factors for areas of the conveyor system other than the scale area.

Participants noted that it was unrealistic and cost prohibitive to totally protect the entire conveyor system from environmental factors such as rain, dust, wind and ice. It was noted that UR.2.1. already protects the indicating elements, lever system, or load cells from environmental factors. Additionally, General Code paragraph G-UR.1.2. Environment states "Equipment shall be suitable for the environment in which it is used including, but not limited to, the effects of wind, weather, and RFI." This allows the weights and measures official to take appropriate actions based upon an official inspection. The participants agreed to recommend that the proposal be amended to remove the wording regarding the entire conveyor be protected from any precipitation.

Several participants were concerned with the term "structure" and what all is encompassed. The majority of the participants agreed that the term "structure" is too broad and inappropriate. Additionally, the maximum three-inch clearance in the proposal was intended to be a safety consideration. Although safety is paramount during the operation and inspection of devices, Handbook 44 deals primarily with specifications, tolerances and other technical requirements. Other occupational health and safety agencies appropriately regulate safety issues.

SEMINAR RECOMMENDATION

The Participants on the Belt-Conveyor Scale Technical Seminar recommend that the WWMA amend Developmental Issues -Belt-Conveyor Scale Systems Item 7 by removing the proposed language that protects the belt conveyor from any precipitation, deleting the term "structure" form the proposal, and removing the proposed language in sub-paragraph (b) relating to minimum clearances. The existing proposed amendments to subparagraph (a) are considered appropriate and provides the weights and measures officials and the device user with additional guidance and flexibility regarding the affects of the installation on a belt-conveyor scale.

UR.2.2. Conveyor Installation. - The design and installation of the conveyor leading to and from the belt-conveyor scale is critical with respect to scale performance. The conveyor may be horizontal or inclined but, if inclined, the angle shall be such that slippage of material along the belt does not occur. Installation shall be in accordance with the scale manufacturer's instructions and the following:

(a) Installation General. - A belt-conveyor scale shall be so installed that neither its performance nor operation will be adversely affected by any characteristic of the <u>installation, including but not limited to, the</u> foundation, <u>supports, covers,</u> or any other equipment.

(b) Live Portions of Scale. - All live portions of the scale shall be protected by appropriate guard devices to prevent accidental interference with the weighing operation.

(b) thru (n) remain unchanged by this developing item

Item 8 D UR.3.2. (b) Maintenance

Source: NIST-OWM and interested NTETC Belt-Conveyor Scale Sector Members. This item originated from the Western Weights and Measures Association (WWMA) and first appeared as Appendix C (Item 360-3) Developing Issues on the Committee's 2000 agenda.

Recommendation: Add a new paragraph to paragraph UR.3.2. Maintenance (b) and modify paragraph UR.3.2.(b) as follows:

UR.3.2. Maintenance

(c) Simulated load tests or materials tests shall be conducted at periodic intervals between official ~~tests~~, <u>certification, after the scale system runs under a no-load condition for at least (XX) minutes</u> to provide reasonable assurance that the device is performing correctly.

<u>A materials test may be performed under any environmental conditions and in any ambient temperature range.</u>

The action to be taken as a result of materials test error is as follows:

Background/Discussion: The proposal is intended to prevent any party from benefiting from the zero bias of a belt-conveyor scale system.

The WWMA finds some merit in this new proposal, but it recommends the proposal be given developmental status.

During the 2001 NCWM Interim meeting, NIST-OWM and a member of the NTETC Belt-Conveyor Scale Sector provided the S&T Committee with an update on activities related to the Belt-Conveyor Scale Systems Developing Items on the Committee's agenda. They reported developing alternate language for Items 1 through 9 to better clarify the intent of each item and asked that the Committee replace the existing recommendations with the revised language. The revised language shown above replaces the original proposal in the recommendation. NIST-OWM reported that it will host a Spring 2001 Belt-Conveyor Technical Seminar to address developing belt-conveyor scale system issues. The Committee encourages interested parties to participate in this seminar and to provide input on these developing items.

SEMINAR DISCUSSION

The intent of the proposal was to encourage users to perform materials test, simulated load tests under any environmental condition that the scale is operated in normal use (hot, cold, rain, etc.) and to verify the zero-load condition of the belt-conveyor scale system. The proposal as written only instructs the operator to run the belt empty before conducting the periodic simulated or material tests and does not require the operator to perform a zero-load test, which is the only way to check the no-load condition of the belt. It was suggested to amend the proposal to specifically require zero-load tests between official tests.

Seminar participants also indicated that the statement regarding testing in any ambient condition in not needed and is sufficient addressed in paragraph "N.2. Conditions of Tests". Additionally, it was agreed to remove the term "official certification" from the proposal and leave in the term "official tests". Although "certification" implies that the device has passed an official test, the introduction of new terminology into the code is not justified by concerns of weights and measures officials and device users.

SEMINAR RECOMMENDATION

The Participants on the Belt-Conveyor Scale Technical Seminar recommend that the WWMA amend Developmental Issues -Belt-Conveyor Scale Systems Item 8 by removing the instructions for the belt to be run empty during the periodic tests between official certifications and the statement about conducting the test at any ambient condition.

UR.3.2. Maintenance

(b) Simulated load tests or materials tests<u>, and zero load tests</u> shall be conducted at periodic intervals between official tests to provide reasonable assurance that the device is performing correctly.

The action to be taken as a result of the <u>material tests or simulated load</u> tests is as follows:

Item 9 D UR.3.2. (e) Maintenance

Source: NIST-OWM and interested NTETC Belt-Conveyor Scale Sector Members. This item originated from the Western Weights and Measures Association (WWMA) and first appeared as Appendix C (Item 360-3) Developing Issues on the Committee's 2000 agenda.

Recommendation: Modify paragraph UR.3.2. Maintenance (e) as follows:

UR.3.2. Maintenance

(e) Records of calibration and maintenance, including conveyor alignment, <u>chart recorder, auto-zero tracking and materials test data</u> shall be maintained on site for at least ~~three~~ <u>seven</u> ~~current~~ <u>previous</u> years to develop as a history of scale performance. Copies of any report as a result of a test or repair shall be mailed to the official with statutory authority as required. The current date and correction factor(s) for simulated load equipment shall be recorded and maintained in the scale cabinet.
(Amended 1991)

Background/Discussion: The WWMA recognized that the chart recorder provides information about the feed rates and performs a separate function from other items already listed UR.3.2. (e). The WWMA asked for input from operators/customers about the necessity of maintaining data for 7 years.

The WWMA recognized pending action on the 2000 NCWM S&T agenda item 321-5 UR.3.2.(c) Maintenance; Scale Alignment (1998 Carryover Item 321-4) may affect this proposal. Consequently, the WWMA recommended that this proposal be given developmental status pending the outcome of the NCWM's actions on 321-4 at the 2000 annual meeting. At the SWMA 2000 Annual Meeting an industry representative questioned the relevance of data more that 30 days old and noted that a belt-conveyor scale system may be rebuilt in a period of seven years or less, which also makes data outdated.

SEMINAR DISCUSSION

The intent of the proposal is to give the weights and measures official, the device user and the customer, records of maintenance and testing. This information could be used by the weights and measures official to verify that the belt-conveyor scale operator has been conducting tests pursuant to paragraph UR 3.2. (b). The retention of chart recorder, zero-load test, and the periodic testing will help the scale operator in defending the condition of a scale in the event of a disputed transaction.

The participants of the seminar agreed that retention of the additional information is of value, but questioned the recommended seven-year retention requirement. One manufacturer indicated that seven-year information retention is required in some jurisdictions outside of the United States. He added that he too felt that a three-year retention of information is sufficient.

Editorial suggestions were noted that "history" should be "recorded" and not "developed". Additionally, the paragraph intends that the user retain the three most recent years of the required information

SEMINAR RECOMMENDATION

The Participants on the Belt-Conveyor Scale Technical Seminar recommend that the WWMA amend Developmental Issues -Belt-Conveyor Scale Systems Item 9 by removing the seven-year information retention requirement, provide additional clarification that the three-year information be of the most recent three-year period and change the phrase " records . . . develop as a history of scale performance" to "records . . . maintained . . . as a history of scale performance."

UR.3.2. Maintenance

> **(e) Records of calibration and maintenance, including conveyor alignment, <u>chart recorder, zero-load test and material test data</u> shall be maintained on site for at least <u>the</u> three <u>con</u>current years ~~to develop~~ <u>as</u> a history of scale performance. Copies of any report as a result of a test or repair shall be mailed to the official with statutory authority as required. The current date and correction factor(s) for simulated load equipment shall be recorded and maintained in the scale cabinet.**

After the seminar, the NIST Technical Advisor noted that the information that is retained in not exclusively maintenance records. The WWMA might want to consider renumbering paragraph "UR.3.2. Maintenance (e)" to a new paragraph, "UR.3.3. Records" as follows:

> **UR.3.~~2~~<u>3</u>. ~~Maintenance~~ <u>Retention of Maintenance, Test, and Chart Recorder Information. -</u> ~~(e)~~ Records of calibration and maintenance, including conveyor alignment, <u>chart recorder, zero-load test and material test data</u> shall be maintained on site for at least <u>the</u> three <u>con</u>current years ~~to develop~~ <u>as</u> a history of scale performance. Copies of any report as a result of a test or repair shall be mailed to the official with statutory authority as required. The current date and correction factor(s) for simulated load equipment shall be recorded and maintained in the scale cabinet.**

DRAFT Examination Procedures Outline for Belt-Conveyor Scale Systems

SEMINAR DISCUSSION

The importance of making sure that inspectors have training and information needed to conduct he testing and that we are expecting the inspector to be an expert while they may not have the expertise to do the test or proper pre-test inspections. A proper pre-test inspection may save an inspector from wasting time and money on unnecessary tests because of a deficiency that could have been caught during the pre-test inspection. For example the weights and measures official is not expected to perform a structural analysis to verify that structural supports have not effect on the scale as part of the inspection. Concerns were raised about the word “inspect” and suggested that the term “verify” be replaced as appropriate. It is easier for an inspector to verify that various items are in place or working than it is for them to be able to inspect items they may not be an expert in.

The history of development of an EPO by NIST is to define minimum testing according to NIST Handbook 44. Questions such as “what would be a good test of a belt-conveyor scale” and “what are the minimum things that an inspector should be doing” are the goals of an EPO. It is up to the jurisdiction to apply the test criteria according to the application and jurisdictional requirements.

It should also be noted that the EPO could be used by scale operators and service agencies as guidelines for proper maintenance and monitoring a scales performance between official tests.

The draft EPO was reviewed page by page during the seminar. Most of the changes were minor and non-substantive. Additionally, the seminar participants recommended that CEMA definitions be included in the EPO definitions. The NIST Technical Advisor obtained an electronic copy of the CEMA definitions and illustrations of various belt-conveyor parts. The NIST Technical Advisor included many of the CEMA illustrations in this EPO.

SEMINAR DISCUSSION

INTRODUCTION

The following Examination Procedures Outline (EPO) has been prepared as a guide for determining if devices are correct and suitable for commercial service <u>for owners, users, operators, service agencies and officials with statutory authority.</u> The outline describes what is considered a <u>minimum</u> examination, preceding official action. The definitions and illustrations of terms used in these procedures are included for reference.

References to sections of NIST Handbook 44 have been included for easier location of specific wording. The section suffix numbers in brackets [1.10, 2.20, 3.30, etc.] direct you to the specific portion of Handbook 44.

Examples:

G-UR.4 [1.10] --- User <u>Requirement</u> from the [<u>General Code</u>]

N.1.1 [2.21] --- Test <u>Procedures</u> or Notes from the [<u>Scale Code</u>]

Periodic changes to the procedures will be made to accommodate code changes and new developments in device technology.

Suggestions for improving the procedures outline are welcome at any time.

Pre-test Inspection - Conveyor

1. Material handling

Inspect the entire material handling system, from load point to the discharge, inspecting all hoppers and transfer chutes, to ensure that there is no build up of material or spillage that might create problems.

Material build up in the hoppers or chutes must be removed prior to testing. Spillage must be removed and the cause of the spillage repaired prior to the test.

2. Scale Conveyor

If practicable, the scale should be material tested to determine the as-found accuracy of the scale before conveyor inspections and corrections are made. UR.3.2 [2.21]

Inspect the entire conveyor. The inspection should include worn chutes, belting, infeed skirting, tail pulley, impact idlers, troughing idlers, training idlers, return idlers, bend pulleys, snubbing pulley, head pulley, belt scrapers, gravity take-up, take up weight, support steel, feed points and the conveyor drive. UR.2 [2.21]

Inspect all idlers of the conveyor, both loaded and unloaded. If the belt will not conform to the requirements of NIST Handbook 44 or faulty bearings are found then this must be corrected. UR.2.2. (n) [2.21]

Inspect the skirt boards at the infeed point for proper alignment. If any spillage at this point exists, adjustments must be made to eliminate all spillage prior to the materials test. UR.2.2. (a) [2.21] UR.2.2. (m) [2.21]

The conveyor structure must be rigid in design to prevent vibration and significant deflection. UR.2.2. (a) [2.21]

Inspect the Gravity Take Up Unit, the bend pulley must travel freely when the belt is running and not bottom out at start up. UR.2.2. (d) [2.21]

Inspect the Drive unit for slippage or spillage, which must be corrected before testing begins. UR.2.2. (a) [2.21]

3. Scale

Inspect the weigh area idlers for worn bearings and belt alignment. The weigh area idlers should freely rotate and have no signs of material build-up, holes in the rollers, or corrosion. Excessive noise from the idlers indicates friction or worn bearings that may also affect scale performance. Inspect any check rods on the structure for binding. ~~Check alignment bushings for wear and corrosion.~~ UR.2.2. (a) [2.21]

Inspect the speed sensor; if the speed sensor is mounted on a non-driven bend pulley, it should be on the clean side of the return belt. Also check the bend pulley wrap to ensure positive contact. Check for material build-up on the speed sensing pulley, ensure sensor coupling is secure and has no worn bearings. The sensor should be corrected if a loose bearing exists on the shaft. UR.2.4. [2.21] G-UR.4.2. [1.10]

Inspect the weighbridge support steel and bracing for the load cells and weighbridge. UR.2.2. (j) [2.21]

Inspect belt alignment. The belt must not extend beyond the edge of the idler roller in any area of the conveyor, either empty or loaded. UR.2.2. (n) [2.21]

Inspect belt composition and maintenance. The belt should make full contact with the center carry roller of the idlers. UR.2.2. (l) [2.21]

Based on observations, corrections must be made to the scale or the area surrounding the scale if foreign material adheres to the scale structure at any time during normal operation and materials tests. UR.3.2. (a) [2.21]

Pre-Test Inspection – Scale

1. Identification. G-S. 1 [1.10]

   1.1. Manufacturer's name or trademark, model number, and serial number on major components.

2. Type

   2.l. Units installed after January 1, 1986 must be equipped with a recording element and a rate of flow indicator and recorder. S.1. 1 [2.21]

3. Marking requirements. S.4 [2.21]

   3.1. Rated capacity - units of weight per hour, both maximum and minimum. S.4 (a) [2.21]

   3.2. The value of the scale division. S.4 (b) [2.21]

   3.3. The belt speed in terms of feet or meters per minute at which the belt will deliver the rated capacity. S.4 (c) [2.21]

   3.4. The belt load in terms of pounds per foot or kilograms per meter (determined by material tests). S.4 (d) [2.21]

   3.5. On all new units installed after January 1, 1986, the operational temperature range if it is other than - 10 ^{o}C to 40 ^{0}C (14 °F to 104 °F).

   3.6. For units installed after January 1, 1986 check the rated belt speed and load of the Scale is within the parameters outlined in the manufacturers certificate of conformance. S.4 (e) [2.21]

4. Provisions for Sealing

   The MWT shall not be resettable without breaking a security means for devices manufactured after January 1, 1986. S.1.7. [2.21]

   Provisions shall be made to seal access to load cell and integrator calibration adjustments. Devices manufactured after January 1, 1998 are permitted to have an approved means for providing security such as a data change audit trail available to the inspector at the time of inspection. S.5. [2.21]

Pre-Test Determinations

1. Determine if the conveyor scale is suitable for the amount of product weighed.

   1.1. The belt-conveyor scale system shall be operated between 35 and 98 percent of its rated capacity. Record the maximum and minimum feed rate and run time it takes to deliver a test load. Determine the percentage of rated capacity. UR.1 [2.21]

   Example:

   The scale has a rated capacity of 500 tph.
   A test load of 80 tons was delivered in 15 minutes.

   [(60 minutes in an hour/15 minutes) x test load] = 4 hours x 80 tons
   4 hours x 80 tons = 320 tph (feed rate in tph)

   $\frac{320 \text{ tph}}{500 \text{ tph}} \times 100 = 64\ \%$ (feed rate as a percentage of scale capacity

   1.2. Delivered quantities of less than the minimum test load shall not be considered a valid weighment. UR.1.1 [2.21]

   1.3. Material must not slip on the belt due to the angle of belt incline, belt speed or loading process. Material slipping backwards (in the opposite direction of belt travel) on an inclined belt-conveyor scale results in material being weighed more than once. UR.2.2 (i) [2.21] UR.2.2 (m) [2.21]

2. Recording elements and recorded representations. The value of the scale division of the recording element shall be the same as that of the indicating element. The belt-conveyor scale system shall; S.1.4 [2.21]

   · record the initial indication and the final indication of the master weight totalizer*,
   ·the quantity delivered*,
   ·the unit of measurement (i.e., kilograms, tonnes, pounds, tons, etc.),
   ·the date, and time.

   This information shall be recorded for each delivery*.

   (Nonretroactive as of January 1, 1986.)
   (* Nonretroactive as of January 1, 1994.)

3. Value of the scale division. S.1. 3 [2.21]

   3.1. Scales installed after January 1, 1986 must have a scale division not greater than 1/1000 of the minimum totalized load (0.1 percent). S.1. 3.1 [2.21]

   3.2. Scales installed before January 1, 1986 must have a scale division not greater than 1/1200 of the rated capacity of the device. S.1.3.2 [2.21]

   <u>Example:</u>

   Belt Scale Capacity = 1000 tons/hour

Max. Smallest Unit = $\frac{1000}{1200}$ = 0.83 ton

0.83 is rounded to 0.50 to coincide with the MWT minimum increment and paragraph.

4. Determine the minimum amount of material to pass over the belt-conveyor scale for materials test.

Each test is to be run for not less than: N. 2 [2.21]

a) 1000 scale divisions,
b) at least three revolutions of the belt,
c) and 10 minutes of operation or a normal weighment which ever is greater.

5. Determine tolerance requirements.

5.1. Zero-load test. The variation between the beginning and ending reading of the master weight totalizer shall not be more than +/- 1 scale division when the instrument is operated at no-load for a period of time equivalent to that required to deliver the minimum totalized load of 1,000 scale divisions. N. 3. 1 [2.21]

The zero-load test shall be conducted over a whole number of belt revolutions of not less than 3 revolutions or 10 minutes of operation, whichever is greater.

The totalizer shall not change more than three scale divisions during any portion of the zero-load test.

5.2. Materials test. Maintenance and acceptance tolerances on the materials test, relative to the weight of the material, shall be 0.25 percent (1/400) of test load. T. 1 [2.21]

5.3. Repeatability test. The variation in the values obtained during the conduct of the materials test (3 individual tests are required during initial testing, 2 individual tests are required during subsequent testing) shall not be greater than 0.25 percent (1/400). T. 2 [2.21] N.3.2(f) [2.21]

6. The containers used in the material test should be inspected. They may be railroad cars, trucks, hoppers, or barges. They must not leak and should be large enough so that overloading does not occur. N.3.2. (a) [2.21]

7. Determine accuracy of reference scale. (Refer to reference scale test procedure in EPO NO. xx, item 1 under Pre-Test Determinations.) N.3.2. (d) [2.21]

After the reference scale test and before commencing the belt scale materials test, attempt to establish the weight of a reference load. This reference load can be used to re-verify the reference scale after the reference scale test equipment has left the test site. N.3.2. (e) [2.21]

8. Arrange to pre-weigh or post-weigh material over the reference scale. N. 3.1. [2.21]

9. **Material test**

Note the following conditions before starting the test. N.3.2. (f) [2.21]

a) Current weather and temperature.
b) The "as found" zero and span numbers.
c) The zero-load repeatability test, before and immediately after the official materials test.
d) The "as found" material test runs (two (2) are required). N.3.2. (g) [2.21]

Note: If this is a subsequent test and the two as found condition tests are within tolerance and no adjustment has been made to span since the last material test, then the material test is complete.

An initial verification test requires at least three (3) individual test runs. The span may be corrected after the two as found runs, but three (3) individual test runs are required after the span adjustment.

Tests

1. Zero-load test. N.3.1 [2.21]

1.1. If the belt has been idle 2 hours or more, run empty for 30 minutes if temperature is 5 °C (41 °F) or above (longer if temperature is less than 5 °C (41 °F)) before starting the zero-load test.

1.2. Run the empty belt-conveyor scale for a period of time necessary to deliver the minimum totalized load of 1,000 scale divisions. The variation between the beginning and ending indications of the totalizer indication should not change more than 1 scale division.

If the belt conveyor scale has not run three complete revolutions and ten minutes, allow the test to continue until both conditions are satisfied. N.3.2 [2.21] S.1.5 [2.21]

1.3. During any portion of the test the totalizer shall not change more than +/- 3 scale divisions from its initial indication. A change more than +/- 3 scale divisions indicates excessive variation in the weight of the belt.

2. Material test.

2.1. At the start of the test, write down the starting totalizer reading. Pass material over weigh belt using either pre-weighed material with controlled delivery or weigh material delivered from the belt. N.3.2. [2.21]

Record the maximum and minimum feed rates during the delivery of the materials. Calculate the average feed rate.

Belt must be loaded so that the rate of flow indicator is maintained between 35% and 98% of rated hourly capacity. S.1.5. [2.21] UR.1. [2.21]

Different feeders or different feed rates may require additional materials tests. N.2. [2.21] UR.2.2. (m) [2.21]

2.2. Compare net weight of material passed over belt as shown by belt totalizer with net weight established by reference scale and determine error.

Example: Calculate error and tolerance when 101.7 tons of pre-weighed material is passed over a 500 ton per hour belt scale and the final totalizer reading is 101.9 tons.

Belt totalizer reading		101.9 tons
Pre-weighed material		101.7 tons
Error	+	0.2 ton

% Error = $\frac{+\ 0.2 \text{ tons}}{101.7 \text{ tons}} \times 100 =$

+ 0.197% (complies or meets tolerance)
Tolerance: +/- 0.25 %

T.1 [2.21]

(Range of allowable totalizer readings 101.4 to 102.0 tons)

3. Repeatability test. A material test should be performed 2 times to determine repeatability of scale and must repeat within 0.25% on all tests. T.2 [2.21]

The results of all these tests shall be within tolerance limits and shall not be averaged. N.3.2. (g) [2.21]

4. Simulated test. A simulated test, as recommended by the manufacturer, shall be performed within 12-hours after a material test has established scale accuracy. Record the established factor that relates the results of the simulated load tests to the results of the materials tests. N.3.3 (b) [2.21]

Results of the simulated load test shall repeat within 0.1 percent. N.3.3. (c) [2.21]

5. Post-test inspection of the conveyor and the material handling system.

Walk through the complete system from load point to discharge, inspecting all hoppers, feeders, belts, and transfer chutes for spillage and build up of material.

Any spillage occurring during the material test should be noted and reported, however insignificant the spillage may seem.

Any material build up on the scale structure or belt should also be noted and reported.

If material build up or spillage that occurred during the material test is determined to be large enough to have biased the test and the actual weight cannot be determined from a traceable standard then the test is not valid.

This includes test material that may have been left in the containers during the unloading process.

Definitions

A

Accuracy - The ratio of the error to the full-scale output or the ratio of the error to the output, as specified, in percent.

Alignment - The proper adjustment or correct relative position of the idler frames and rollers to the movement of the belt.

Audit Trail [NIST Handbook 44] - An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device.

Automatic Zero Track - Automatic means provided to maintain zero balance during times when the conveyor belt is running empty without the intervention of an operator.

Auxiliary Indicator [NIST Handbook 44] - Any indicator, other than the master weight totalizer, to indicate the weight of material that has been determined by the scale.

B

Belt Conveyor [NIST Handbook 44]- An endless moving belt for transporting material from place to place.

Belt Conveyor Scale [NIST Handbook 44]- A device that employs a weighing element in contact with a conveyor belt to sense the weight of the material being conveyed and the speed (travel) of the material, and integrates these values to produce total delivered weight.

Belt Scraper - A scraping or wiping device used to clean residue from the belt on the return side (underside) of the belt in the vicinity of the head pulley. The wiper is affixed to one end of an arm that has a weight hanging from the other end. The weight is such that the wiper is held against the belt.

Belt Travel (Speed) Sensor - The belt travel (speed) sensor transduces the belt travel (speed) to a form acceptable to the mass totalizer.

Bend Pulley - A roller placed on the return side (underside) of a conveyor belt to turn its direction or to measure speed of belt.

Bend Pulley [CEMA] **–** A pulley on the return side of the conveyor to change the belt travel direction.

C

Carriage (Scale Suspension) - The scale carriage (scale suspension) transmits the forces resulting from the belt load and directs those forces to the load sensor(s). Weighing idlers are rigidly attached to the carriage.

CEMA – Conveyor Equipment Manufacturers Association

Chain or Test Chain - See Test Chain.

Chart Recorder [NIST Handbook 44] - A device used with a belt conveyor scale which records the rate-of-flow of bulk material over the scale at any given time. A recorded chart together with a record of weight constitutes proof of weight.

Concave Curve [NIST Handbook 44] - A change in the angle of inclination of a belt conveyor where the center of the curve is above the conveyor.

Convex Curve [NIST Handbook 44] - A change in the angle of inclination of a belt conveyor where the center of the curve is below the conveyor.

Conveyor Stingers [NIST Handbook 44] - Support members for the conveyor on which the belt conveyor scale and idler frames are mounted.

Counter (Remote) - A numerical display in a location remote from the scale showing the weight of material that has been conveyed over the scale.

D

Disc Chart - See Chart Recorder.

E

EMI Influence - Electromagnetic Interference -Electrical disturbances that propagate into electronic and electrical circuits and may cause deviations from normally expected performance. The interference may be caused by variable speed drives, relays, or solenoid actuations.

EMI Influence [CEMA] – Electromagnetic Interference, (EMI), is any undesirable electromagnetic emission or any electrical or electronic disturbance, man-made or natural, which causes an undesirable response, malfunctioning or degradation in the performance of electrical equipment. This term is often used interchangeably with RFI (radio-frequency-interference). Technically, EMI refers to the type of energy (electromagnetic), while RFI refers to the frequency (range of the noise frequency). Both EMI and RFI describe unwanted signals (noise) that a filter is intended to eliminate. The most common offender in the radiation of EMI is the electrical power cord of the electronic device itself. Since the power cord can act as an antenna, conducted EMI can also become radiated interference. EMI propagates through conduction over signal and power lines and through radiation in free space.

Event Counter [NIST Handbook 44] - A non-settable counter that increments once each time the mode that permits changes to sealable parameters is entered and one or more changes are made to sealable calibration or configuration parameters of a device.

Event Logger [NIST Handbook 44] - A form of audit trail containing a series of records where each record contains the number from the event counter corresponding to the change to a sealable parameter, the identification of the parameter that was changed, the time and date when the parameter was changed, and the new value of the parameter.

F

Feeders - See Infeed.

G

Gate - See Infeed.

H

Handbook 44 – National Institute of Standards and Technology (NIST) Specification, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, Handbook 44.

Head Pulley [NIST Handbook 44] - The pulley at the discharge end of the belt conveyor. The power drive to drive the belt is generally applied to the head pulley.

Head Pulley [CEMA] - The pulley at the discharge end of the belt conveyor.

I

Idler - Adjustable - Freely turning cylinders mounted on a frame to support the conveyor belt. The vertical part of the frame supporting the wing cylinder is constructed with a bolted plate allowing shims to be used for vertical adjustment of the wing cylinder.

Idler, Carry [CEMA] **–** Device to support the loaded run of the belt. Can be a single flat roll or multiple rolls with the outer rolls inclined upward with the center roll horizontal.

Idler, Return [CEMA] **–** frame mounted rolls to support the return run of a belt.

Idler Space [NIST Handbook 44] - The center-to-center distance between idler rollers measured parallel to the belt.

Idler Frame - The frame or device that holds the idler rollers, affixed to the conveyor stingers.

Idler or Idler Rollers [NIST Handbook 44] - Freely turning cylinders mounted on a frame to support the conveyor belt. For a flat belt the idlers may consist of one or more horizontal cylinders transverse to the direction of belt travel. For a trough belt, the idler will consist of one or more horizontal cylinders and one or more cylinders at an angle to the horizontal to lift the side of the belt to form a trough.

Infeed - The gate, short belt, vibrator feeder, stoker feeder, etc., that deposits material on the belt conveyor to be weighed.

Integrator - The "heart" of the belt conveyor scale. A device which integrates the belt travel (speed) with the weight of material conveyed to produce units of measure (kilogram, tons or pounds) ~~per hour~~.

L

~~**Lagged Pulley** - A drive pulley with a vulcanized rubber coating molded in a high friction pattern to prevent slippage of the belt under load.~~

Lagged Pulley [CEMA] **–** Conveyor pulleys can be covered with some form of rubber, fabric or other material. Lagging is used to increase the coefficient of friction between the belt and pulley. Another purpose is to reduce wear on the pulley face and to effect a self-cleaning action on the surface of the pulley.

Loading Point - The location at which material to be conveyed is applied to the conveyor.

M

Manual Zero-Setting Mechanism [NIST Handbook 44] - Nonautomatic means provided to attain a zero balance indication by the direct operation of a control.

Master Weight Totalizer [NIST Handbook 44] - A non-resettable device used with a belt conveyor scale to indicate the weight of material, which has been conveyed over the scale. The master weight totalizer is the primary indicating element of the belt conveyor scale.

Materials Test [NIST Handbook 44]- The test of a belt-conveyor scale using material (preferably that for which the scale is normally used) that has been weighed to an accuracy of 0.1 percent.

~~**Minimum Delivery** - The least amount of weight that is to be delivered as a single weighment by a belt-conveyor scale system in normal use. Handbook 44?~~

Minimum Totalized Load [NIST Handbook 44]- The least amount of weight for which the scale is considered to be performing accurately.

N

Normal Weighment - The amount of weight for which a ticket is printed in normal usage.

O

Official With Statutory Authority [NIST Handbook 44]- The representative of the jurisdiction(s) responsible for certifying the accuracy of the device.

P

Printer - A device used to imprint the weight of material that has passed over the scale in a given time.

Pulley - A cylindrical roller over which the belt passes to change direction, such as the head pulley or tail pulley or bend pulley.

Pulley [CEMA] – A continuous rim and two end disks fitted with compression hubs and intermediate stiffening disks welded inside the rim.

R

Radio Frequency Interference (RFI) [NIST Handbook 44] – Radio frequency interference is a type of electrical disturbance that, when introduced into electronic and electrical circuits, may cause deviations from the normally expected performance.

Radio Frequency Interference (RFI) [CEMA] **–** Radio frequency interference, RFI, is any undesirable electrical energy with content within the frequency range dedicated to radio frequency transmission. Conducted RFI is most often found in the low frequency range of several kHz to 30MHz. Radiated RFI is most often found in the frequency range from 30MHz to 10GHz. Typical sources of conducted interference include switching power supplies, ac motors, and microprocessors. In short, just about any electrical and electronic device has the potential to generate conducted and radiated interference. RFI propagate through conduction over signal and power lines and through radiation in free space.

Rate-of-Flow Indicator - A device that displays actual flow rate across the scale. Usually expressed in weight/time.

Rated Scale Capacity - The value representing the weight that can be delivered by the scale in one hour.

Recorder - Analog - A system of indication or recording in which values are presented as a series of graduations in combination with an indicator, or in which the most sensitive element of an indication system moves continuously during the operation of the device.

Recorder - Digital - A system of indication or recording of the selector type or one that advanced intermittently in which all values are presented digitally, or in numbers. In a digital indication or recording element, or in digital representation, there are no graduations.

Recording Element [NIST Handbook 44] - An element incorporated in a weighing or measuring device by means of which its performance relative to quantity or money value is permanently recorded on a tape, ticket, card, or the like, in the form of a printed, stamped, punched, or perforated representation.

Reference Scale - The scale, tested to an accuracy of 0.1%, used to determine the weight of material used in an official test. Gross and tare weights shall be obtained on the same scale. Examples of types that may be used are: Static Vehicle Scales; Static Track Scales; Uncoupled-In-Motion Track Scales; Weigh Bins; and Garner Systems.

Repeatability - The ability of a device to reproduce readings when the same measured (physical quantity, property or condition which is measured) value is applied to it consecutively under the same condition.

~~**Rope Conveyor** - See Cable Conveyor.~~

S

Scale Area - The scale area refers to the scale suspension, weigh idlers attached to the scale suspension, 5 approach (-), and 5 retreat (+) idlers.

Scale Division, Value of (d) [NIST Handbook 44] - The value of the scale division, expressed in units of mass, is the smallest subdivision of the scale for analog indication or the difference between two consecutively indicated or printed values for digital indication or printing. (Also see “verification scale division.”)

Semi-Automatic Zero-Setting Mechanism - Automatic means provided to attain a direct zero balance indication requiring a single initiation by an operator.

Security Means [NIST Handbook 44] - A method used to prevent access by other than qualified personnel, or to indicate that access has been made to certain parts of a scale that affects the performance.

Simulated (Load) Test [NIST Handbook 44] - A test using artificial means of loading the scale to determine the performance of a belt-conveyor scale.

Skirting [NIST Handbook 44] - Stationary side boards or sections of belt conveyor attached to the conveyor support frame or other stationary support to prevent the bulk material from falling off the side of the belt. (Usually used at infeeds.)

~~**Snub Pulley** – A non-driven pulley used to increase the wrap angle on the drive pulley. See Lagged Pulley.~~

Snub Pulley [CEMA] – A pulley contacting the dirty side of the return belt used to increase the belt wrap on the adjacent head or tail Pulley.

Stacking Conveyor - A conveyor, usually supported by cables, with the ability to change the angle of incline of elevation of the head pulley. The conveyor or structure may also be mounted on wheels allowing radial discharge of the conveyed product.

Strain-Load Test [NIST Handbook 44]- The test of a scale beginning with the scale under load and applying known test weights to determine accuracy over a portion of the weighing range. The scale errors for a strain-load test are the errors observed for the known test loads only. The tolerances to be applied are based on the known test load used for each error that is determined.

String Line - A line used to align the idler frames and rolls throughout the weight sensing area. Care should be taken in selection of line material to avoid excessive deflection due to line weight or stretching.

Stringer - See Conveyor Stringer.

Strip Chart - See Chart Recorder.

T

Tail Pulley [NIST Handbook 44] - The pulley at the opposite end of the conveyor from the head pulley.

Tail Pulley [CEMA] - Pulley located at the feed end of the conveyor.

Take-up [NIST Handbook 44] - A device to provide sufficient tension in a conveyor belt so that the belt will be positively driven by the drive pulley. A counter-weighted take-up consists of a pulley free to move in either the vertical or horizontal direction with dead weights applied to the pulley shaft to provide the tension required.

Take-up Guides - Guides or tracks on either side of the gravity take-up weight to prevent horizontal movement of that weight.

Test Chain [NIST Handbook 44] - A device used for simulated tests consisting of a series of rollers or wheels linked together in such a manner as to assure uniformity of weight and freedom of motion to reduce wear, with consequent loss of weight to a minimum. (Used for simulated testing.)

Test Weights – A mass standard ~~weight~~(s) applied to the scale suspension. Equivalent lb/ft loading is dependent on total weight, idler spacing and conveyor incline. Used for simulated testing.

Totalizer – As used in the EPO, same as Integrator and master weight totalizer.

Tolerance - A value fixing the limit of allowable error or departure from true performance of value.

Tracking Idlers - Usually small cylinders vertically mounted on shafts affixed to a swivel idler frame. The purpose is to allow the side of the belt to rub against the tracking idler, forcing the swivel idler frame to turn, thus restrain the belt.

Tracking Idlers [CEMA] - Fixed guide rolls placed perpendicular to the edge of the conveyor. They are not normally recommended as continuous contact with the conveyor belt edge accelerates belt edge wear.

Training Idlers [NIST Handbook 44] - Idlers of special design or mounting intended to shift the belt sideways on the conveyor to assure the belt is centered on the conveying idlers.

Training Idlers [CEMA] - Typically a three roll idler with the roll carrying frame mounted on a central pivot perpendicular to the conveyor belt. As the belt traverses the rolls, the idler will pivot urging the belt to return to the conveyor centerline.

Tripper [NIST Handbook 44] - A device for unloading a belt conveyor at a point between the loading point and the head pulley.

W

Weighment - A single complete weighing operation

Wing Pulley [NIST Handbook 44] - A pulley *(usually used as the tail pulley)* made of widely spaced metal bars in order to set up a vibration to shake loose material off the underside (return side) of the belt. (*The use of such a pulley is definitely not recommended unless the conveyor stringers under the scale are thoroughly braced with their own support.)*

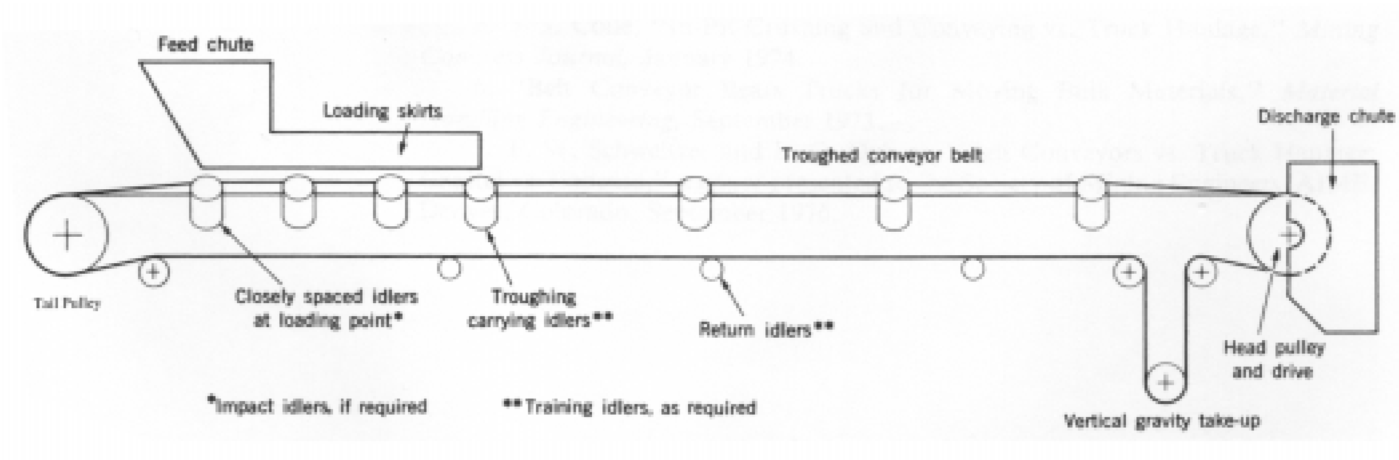
Wing Pulley [CEMA] - Pulleys that have a number of steel wing plates that extend radially from the longitudinal axis of two compression type hub assemblies and are equally spaced about the pulley circumference. Used to effect a cleaning action of the belt.

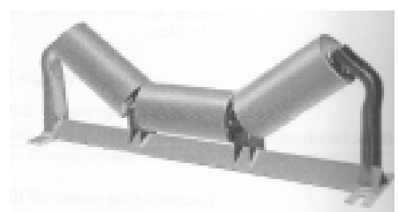
Z

Zero-Setting Mechanism [NIST Handbook 44] - Means provided to attain a zero balance indication with no load on the load-receiving element. The types of these mechanisms are:

> **Manual Zero-Setting Mechanism** - Nonautomatic means provided to attain a zero balance indication by the direct operation of a control.
>
> **Semiautomatic Zero-Setting Mechanism** - Automatic means provided to attain a direct zero balance indication requiring a single initiation by an operator.
>
> **Automatic Zero-Setting Mechanism** - Automatic means provided to maintain zero balance indication without the intervention of an operator.

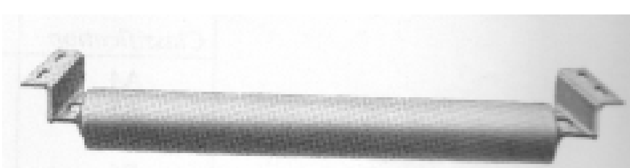
CONVEYOR EQUIPMENT MANUFACTURING ASSOCIATION
CEMA - CONVEYOR EQUIPMENT ILLUSTRATIONS

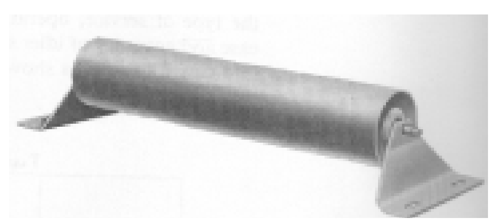




TRAINING IDLER

TROUGH IDLER



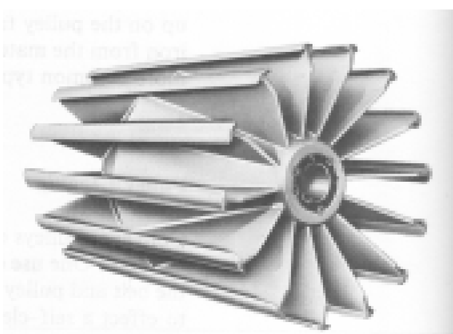


IDLER, RETURN – frame mounted rolls to support the return run of a belt.

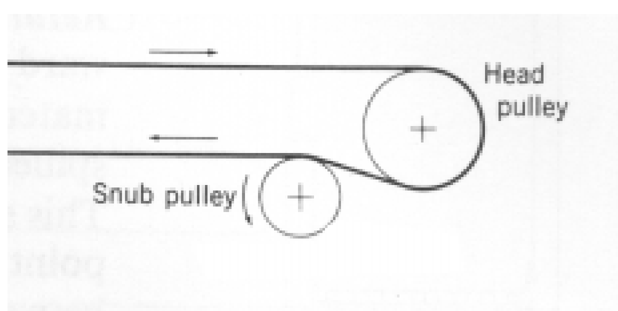
FLAT IDLER

PULLEY

LAGGED PULLEY



WING PULLEY



SNUB PULLEY

Requirements for Metrological Audit Trails

Tables for "typical features and parameters to be sealed" are in Publication 14 for other types of weighing and measuring devices, however, a similar table has not been developed for belt-conveyor scales.

The following background information has been extracted from the type evaluation checklist in Publication 14. The background and philosophies of sealing can be used to determine the belt-conveyor scale parameters that need to be protected by a security means.

The table of "typical features to be sealed" will be submitted to the National Type Evaluation Technical Committee Sector and the NTEP Committee for further discussion and possible incorporation into Publication 14.

Background Information Extracted from Publication 14

Appendix for the Audit Trail

Scope

This discussion lists the requirements for the acceptable forms of metrological audit trail, which are recognized by the National Conference on Weights and Measures as providing acceptable security for commercial weighing and measuring devices. The criteria adopted by the NCWM in July 1993 further define the minimum forms of metrological audit trail that would be acceptable under the General Code paragraph G-S.8. Provisions for Sealing Electronic Adjustment Components.

Remote configuration capability of commercial weighing and measuring devices was a major consideration in developing the criteria ultimately adopted by the NCWM. Weights and measures officials are concerned that the use of such new features might lead to increased fraudulent use of devices unless new, more appropriate means of sealing are also implemented.

The following specifications are based upon requirements adopted by the NCWM July 1993.

Definitions

The following definitions apply to the discussion of metrological audit trails. Those definitions, which were added to NIST Handbook 44 as a result of NCWM action in July 1993, are indicated by *italicized* type.

Adjustment mode. An operational mode of a device, which enables the user to make adjustments to sealable parameters, including changes to configuration parameters.

Adjustment. A change in the value of any of a device's sealable calibration parameters or sealable configuration parameters.

Audit trail. An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device. (The term addresses all forms of audit trail described in this paper.)

Calibration parameter. Any adjustable parameter that can affect measurement or performance accuracy and, due to its nature, needs to be updated on an ongoing basis to maintain device accuracy, e.g., span adjustments, linearization factors, and coarse zero adjustments.

Configuration parameter. Any adjustable or selectable parameter for a device feature that can affect the accuracy of a transaction or can significantly increase the potential for fraudulent use of the device and, due to its nature, needs to be updated only during device installation or upon replacement of a component, e.g., division value (increment), sensor range, and units of measurement.

Enabling/inhibiting sealable hardware. Physically sealable hardware, such as a two-position switch, located on a remotely configurable device, that enables and inhibits the capability to receive adjustment values or changes to sealable configuration parameters from a remote device.

Event. An action in which one or more changes are made to configuration parameters, or adjustments are made to one value (or values for a set of values) for a calibration parameter, (e.g., adjustments for a set of calibration factors to linearize device output), while in the adjustment mode. If no adjustment is made, then there is no event. In the case of a centralized audit trail, the same values for the same parameter sent to multiple devices shall be considered to be the same event. In the case of a centralized event logger, the event logger must identify both the device and the parameter that was changed.

Event counter. A nonresettable counter that increments once each time the mode that permits changes to sealable parameters is entered and one or more changes are made to sealable calibration or configuration parameters of a device.

Note: *An event counter shall have a capacity of at least 1000 values [e.g., 000 to 999].*

Event logger. A form of audit trail containing a series of records where each record contains the number from the event counter corresponding to the change to a sealable parameter, the identification of the parameter that was changed, the time and date when the parameter was changed, and the new value of the parameter.

Physical Seal. A physical means, such as lead and wire, used to seal a device to detect access to those adjustable features that are required to be sealed.

Remote configuration capability. The ability to adjust a weighing or measuring device or change its sealable parameters from or through some other device that is not itself necessary to the operation of the weighing or measuring device or is not a permanent part of that device.

Remote device. A device that (1) is not required for the measurement operation of the primary device or computing the transaction information in one or more of the available operating modes for commercial measurements or (2) is not a permanent part of the primary device. In the context of this paper, a remote device has the ability to adjust another device or change its sealable configurable parameters.

Remotely configurable device. Any weighing or measuring device with remote configuration capability that permits sealable configuration or calibration parameter values to be deleted, appended to, modified, or substituted in whole or in part by downloading over any type of communications link from another device, such as a geographically local or remote console or computer, whether or not the secondary apparatus is part of the network connecting the devices.

Seal. As a verb, to seal a device is to make a device secure so that access to adjustments and other sealable parameters will be detectable.

Sealable parameters. Calibration and configuration parameters that are required to be sealed.

Unrestricted access to sealable parameters. Unrestricted access means that a physical security seal is not present, so that access to the sealable parameters is available from a remote device at any time at the request of an authorized operator subject to the operating status of the receiving device.

Categories of Device: Two Forms of Audit Trail

Two forms of the audit trail are permitted for belt-conveyor scale systems. The form of audit trail acceptable for a device depends on the capability to adjust the device or change sealable parameters. The form that applies to a particular device depends upon the availability of remote configuration capability to the configuration or calibration parameters of the device. The device categories are listed below, with the category designation number corresponds to the method of changing sealable parameters.

Category 1. A device that does not have remote configuration capability.

These devices may be sealed with either a physical security seal or an audit trail. If an audit trail is used, then the minimum form of audit trail must be provided (see next page).

Category 3. A device that allows virtually unrestricted access to configuration parameters or calibration parameters must have an **event logger** as its minimum form of the audit trail.

An **event logger** contains detailed information on the parameters that have been changed and documents the new parameter values. An event logger requires a significant amount of memory. However, any device to which unrestricted access is given will be part of sophisticated measurement process that will have considerable memory available. A centralized audit trail may be used, but additional criteria apply.

Table S.1.11. Categories of Device and Methods of Sealing

Categories of Device	*Method of Sealing*
Category 1: No remote configuration capability	*Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.*
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password)	*An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to ten times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)*

[Nonretroactive and enforceable as of January 1, 1998.] (Table added 1998)

Minimum Form of the Audit Trail

The minimum form of the audit trail shall consist of two event counters: one for *configuration* parameters and one for the *adjustment* (calibration) parameters (000 to 999 for each counter).

The maximum number of values or parameters that must be retained in event logger memory is 1000. (This limit may not apply to centralized event loggers. See the section titled "Centralized Event Loggers" for details.)

Event Loggers: Acceptable Form of Audit Trail for Category 3 Devices

1. The event logger is the minimum form of audit trail for Category 3 devices (those that have unrestricted remote access to the configuration or calibration parameters.) The event logger shall contain the following information:

Event counter	Date and time	Parameter ID	New value

2. This information shall be automatically entered into the event logger by the device. In the case of centralized event loggers, the parameter identification shall include the device identification to which the event applies. Additional relevant information is permitted, e.g., the identification of the person who made the adjustment or the old value of the parameter that was changed.

3. The date and time shall be presented in understandable format. The date shall include month, day, and year. The time shall include the hour and minutes.

4. A hard-copy printout of the contents of the event logger shall be available upon demand from the device or an associated device on the site of the device installation. The display or printing of the event logger contents shall exclude other non-metrological information, such as transaction data, operator inventory records, or shift totals.

5. An event logger shall retain a minimum of 10 entries for each sealable parameter; it is not required to retain more than 1000 events for all parameters combined. This limit applies to devices for which the event logger is dedicated to a single device (See the section titled "Centralized Event Loggers").

Centralized Event Logger

Remote configuration will be used most frequently when several devices interface with a host computer or other host device. A centralized event logger may be used when several "satellite" devices interface with a host device. The following criteria must be satisfied if a centralized event logger is to be used:

1. If electronic parameters monitored by the event logger are changed at the device, rather than through the device containing the centralized audit trail. The changes shall be transferred to and maintained in the centralized audit trail. It shall not be possible to circumvent the unit containing the audit trail. For example, if the audit trail unit is disconnected or inhibited, the attached network devices shall be inoperable and impossible to adjust electronically when in the network configuration. Mechanical adjustments are not expected to be monitored by the event logger because there will probably be no electrical connection from the mechanical adjustment to the event logger. Sealable mechanical adjustments must be secured by a physical security seal.

2. If the same values for change to a parameter (e.g., the division value for scales) are sent from the host device to several satellite devices, this shall be represented as one event in the logger. If changes are made to individual devices rather than to all attached devices, **the event logger shall identify both the parameter and the device that was changed.** Identification may be by individual devices, groups of devices, or designated as all devices.

3. If a device can be installed in a stand-alone operation, it must have the minimum form of audit trail when installed in the stand-alone mode.

4. A system shall be capable of providing, upon demand, a hard copy of the event logger through the device or through another on-site device.

   The display or printing of the event logger contents shall exclude other non-metrological information such as transaction data, operator inventory records, shift totals, etc.

5. If a centralized audit trail is used for a large number of devices on a network, the logger capacity of 1000 events is not sufficient; in this case at least 1000 events per device is required.

General Requirements for Metrological Audit Trails

When an audit trail is the form of security, minimum forms of audit trail are specified for different categories of devices. The following general requirements for metrological audit trails must be satisfied as part of all three minimum forms of audit trail.

1. The adjustment mode shall address only sealable parameters in order to avoid entering the adjustment mode to access non-sealable parameters that must be routinely changed as part of the normal use of the device. Because

the audit trail requirements intend to satisfy the weights and measures requirements of the U.S. and Canada, any parameters required to be sealed in one country, but not the other, may be included in the adjustment mode and still comply with this requirement. Manufacturers should consult with the weights and measures authority to discuss those parameters that may be questionable regarding whether or not the parameter must be sealed. Manufacturers may choose to incorporate the capability to set a software "switch" that determines whether or not a parameter is sealable. If this is done, then the software switches (that determine whether or not a parameter is sealable) shall be sealable.

2. When a remotely configurable device is in the remote configuration mode, which means is capable of receiving changes to sealable parameters, the device shall either:

   a. not indicate or record (if equipped with a printer); or
   b. provide a clear and continuous indication that it is in remote configuration mode. Any printed ticket or receipt shall include a message with each ticket or receipt that the device is in the calibration mode.

   A "clear and continuous indication" that the device is in the remote configuration mode must be of such a nature that it discourages the use of the device for normal transactions when in this mode. This may be a partial obscuring of the numbers, an alternating display message, or some other obvious indication. The lighting of an annunciator is not sufficient. If values can be printed when in the configuration mode, the system shall record a message to indicate that the system in the configuration mode.

3. An event counter shall have a capacity of at least 1000 values, (e.g., 000 to 999).

   a. The event counter for calibration parameters shall increment only when a change is made to at least one sealable calibration parameter during an event (during the time when in the adjustment mode). The counter shall increment only once regardless of the number of changes made while in the adjustment mode. When the calibration mode is entered, but with no changes being made, this does not constitute an event, and the counter must not increment.

   b. The event counter for configuration parameters shall increment only when a change is made to at least one sealable configuration parameter during an event (during the time when in the configuration mode). The counter shall increment only once regardless of the number of changes made while in the configuration mode. When the configuration mode is entered with no changes being made, this does not constitute an event and the counter must not increment.

   c. In the case of the event logger, the event counter shall increment once for each change to a sealable parameter since each new value must be retained in the event logger.

   Note: *The criteria in items 3(a) and 3(b) specify the <u>minimum</u> requirements for event counters. A device may have a separate event counter for each sealable parameter. In this case, the corresponding event counter must increment once each time its sealable parameter is changed.*

4. When the storage memory of the **event logger** has been filled to capacity, any new event shall cause the oldest event to be deleted. The event counter provides the necessary information to indicate the number of records that have been overwritten in the event logger as new information overwrites the old records.

5. The audit trail data shall be:

   a. stored in non-volatile memory and shall be retained for at least 30 days if power is removed from the device; and

   b. protected from unauthorized erasure, substitution, or modification.

6. Access to the audit trail information for the purpose of viewing or printing the contents must be "convenient" for the enforcement official.

a. Accessing the audit trail information for review shall be separate from the calibration mode so there is no possibility for the weights and measures official to change or corrupt the device configuration or the contents of the audit trail.

b. Accessing the audit trail information shall not affect the normal operation of a device before or after accessing the information.

c. A key (for a panel lock) may be required to gain access to the means to view the contents of the audit trail. Access may be through the supervisor's mode of operation of the device.

d. Accessing the audit trail information shall not require the removal of any additional parts other than normal requirements to inspect the integrity of a physical seal.

7. The displayed or printed form of the audit trail information shall be readily interpretable by the inspector.

8. The information from an event logger shall be displayed or printed in reverse chronological order from the most recent event to the oldest event. If a device is not capable of displaying all the information for a single event on one line or at one time, the information shall be displayed in blocks of information which are readily understandable.

Discussion: Principles for Determining Features to be Sealed

a. The need to seal some features depends upon:

1) the ease with which the feature or the selection of the feature can be used to facilitate fraud; and
2) the likelihood that the use of the feature will result in fraud not being detected.

b. Features or functions which are routinely used by the operator as part of device operation, such as setting the unit prices on gasoline dispensers and maintaining unit prices in price look-up codes stored in memory, are not sealable parameters and shall not be sealed.

c. If a parameter (or set of parameters) selection would result in performance that would be obviously in error, such as the selection of parameters for different countries, then it is not necessary to seal the selection of these features.

d. If individual device characteristics are selectable from a "menu" or a series of programming steps, then access to the "programming mode" must be sealable.

e. If a device must undergo a physical act, such as cutting a wire and physically repairing the cut to reactivate the parameter, then this physical repair process would be considered an acceptable way to select parameters without requiring a physical seal or an audit trail.

Typical Features and Parameters to be Sealed

Tables for "typical features and parameters to be sealed" are in Publication 14 for other types of weighing and measuring devices, however, a similar table has not been developed for belt conveyor scales.

Calibration Parameters: Calibration parameters are those parameters whose values are expected to change as a result of accuracy adjustments.

Configuration Parameters: Configuration parameters are those parameters whose values are expected to be entered once only and not changed after all initial installation settings have been made.

A junction box that contains calibration (or configuration) adjustments must have provision for sealing.

Devices equipped with internal calibration weights and automatic or semi-automatic calibration do not have to be sealed provided the calibration mechanism and process are not subject to tampering. Sealing is not required because the calibration process for internal calibration systems result in increased accuracy, which is not detrimental to the accuracy of the weighing process.

The following table provides examples of configuration and calibration parameters that are to be sealed. The examples are provided for guidance and are not intended to cover all possible parameters.

Belt-Conveyor Scale Features and Parameters	
Typical Scale Features to be Sealed	**Typical Scale Features and Parameters Not Required to be Sealed**
Coarse zero Automatic or Semi automatic zero limit Dead Band Alarm limit values Span Linearity correction values Number of samples averaged for weight readings Averaging time for weight indications Selection of measurement units (if internally switched and not automatically displayed on the indicator) Division value, d Range of over capacity indications (if it can be set to extend beyond regulatory limits)	Automatic zero-setting mechanism (Selection of total range, e.g., 4 percent or 100 percent of capacity) Display update rate Product codes Commodity unit prices Baud rate for electronic data transfer

Note: *The above examples of adjustments, parameters, and features to be sealed are to be considered "typical" or "normal." This list may not be all inclusive, and there may be parameters other than those listed which affect the metrological performance of the device and must, therefore, be sealed. If listed parameters or other parameters which may affect the metrological function of the device are not sealed, the manufacturer must demonstrate that the parameter will not affect the metrological performance of the device (i.e., all settings comply with the most stringent requirements of Handbook 44 for the applications for which the device is to be used).*

Audit Trails – General

1. Adequate provision shall be made to apply a physical seal without exposing electronics.
2. If the device has a junction box that has calibration adjustments, it must be sealable.
3. Event counters are nonresettable and have a capacity of at least 000 to 999.
4. Event counters increment appropriately.
5. The audit trail information must be capable of being retained in memory for at least 30 days while the device is without power.
6. The audit trail information must be readily accessible and easily read.

7. Accessing the audit trail information for review shall be separate from the calibration mode.
8. Accessing the audit trail information must not affect the normal operation of the device.
9. Accessing the audit trail information shall not require removal of any additional parts other than normal requirements to inspect the integrity of a physical security seal, (e.g., a key to open a locked panel may be required).

Category 1 Devices (No Remote Configuration Capability)

Either:

(a) The device must be sealable with a physical security seal, or

(b) the device must be equipped with at least two event counters (one for calibration and one for configuration parameters).
- calibration parameters event counter
- configuration parameters event counter

Category 3 Devices (Unlimited Remote Configuration Capability)

Category 3 devices have virtually unlimited access to sealable parameters or access is controlled though a password.

1. The device is equipped with an event logger.
2 The event logger automatically retains the identification of the parameter changed, the date and time of the change, and the new value of the parameter.
3. The system is designed to attach a printer which can print the contents of the audit trail.
4. The event logger must have a capacity to retain records equal to ten times the number of sealable parameters in the device, but not more than 1000 records are required.
5. The event logger drops the oldest event when the memory capacity is full and a new entry is saved.

Describe the method used to seal the device or access the audit trail information.

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SEMINAR CONCLUSION

The NIST Technical Advisor will contact belt-conveyor scale manufacturers and ask for a list of configuration and calibration parameters. The list will include which items are protected by a physical security seal, NIST Handbook 44 Electronic security mean, audit trails (either protected or unprotected by a security means), and if any of the parameters can be remotely configured.

After the lists have been received, the NIST Technical Advisor will consolidate the list and prepare a DRAFT table of sealable and non-sealable parameters. The DRAFT will then be circulated to the Belt-Conveyor Scale participants for a letter ballot and comments.

The final DRAFT table of sealable and non-sealable parameters will be submitted the National Type Evaluation Technical Committee-Belt-Conveyor Scale Sector for their review and comments. The ultimate goal is to have the table incorporated into National Type Evaluation Program Technical Checklist and Procedures – NCWM Publication 14

New Belt-Conveyor Scale Issues-

1. Repeatability Tests

Amend the repeatability tolerance in Handbook 44 Section 2.21, Paragraph T.2. Tolerance Values, Repeatability Tests as follows:

T.2. Tolerance Values, Repeatability Tests. – The variation the values obtained during the conduct of materials tests shall not be greater than <u>0.15</u> ~~0.25~~ percent (1/<u>667</u>~~400~~).

Problem: Repeatability of 0.25 percent is a significant variation during the conduct of a materials test. To in sure the belt conveyor scale system is suitable for commercial application; repeatability of 0.15 percent would be more appropriate.

Justification: One jurisdiction reports that belt-conveyor scales in his state have been required to meet this tolerance for several years. After several years of enforcing this policy, there appears that there is no problem meeting this requirement.

SEMINAR DISCUSSIONS

The submitter discussed the justification of this proposal based upon past experiences. It was noted that the conditions of the test must remain constant, such as test preformed at similar flow rates and materials used for the test are stable.

One of the major concerns is the uncertainty introduced by the reference scales. One manufacturer noted that there is zero confidence of uncertainty of reference scales.

To increase the confidence in reference scales, scales need to be adjusted to zero error. The submitter indicated that scale owners in his jurisdiction do not object to the extra testing. This is likely due to the benefit that reference scale owners, who are not the same as the belt-conveyor scale owner, are getting free scale inspections and service.

The NIST Technical Advisor indicated that more scale owners need to have an “uncertainty analysis” performed on the weighing system, test procedures and standards for measurement results to be recognized by ISO, NAVLAP, or other quality management systems.

Another source of uncertainty is the material itself. Moisture loss is just one example.

Another manufacturer reported that he was not comfortable with the repeatability of +/- .2% by itself. Possibly some guidelines could be written that would give an official more discretion to conduct additional testing.

The seminar chairman indicated that installations with onsite reference scale capabilities, more testing can be done, but there may be a problem where the reference scale is located remotely from the belt-conveyor-scale.

The submitter indicated that 0.15 percent repeatability is common with both onsite and remote testing in his jurisdiction. This is probably due to the fact the scale owners are used to the testing performed in that jurisdiction..

Many of the manufacturers would like to see tighter tolerances but question the uncertainties of the reference scale. In their experiences, many reference scales need servicing for every series of material tests.

A question was asked of the submitter if the data included tests performed at different flow rates. The answer was that he had no data on repeatability, and flow rates should be relatively constant for repeatability test. Precedence for this can be seen in most other Handbook device codes with repeatability tolerances.

A couple of the participants indicated that if two tests were close, then a third material test would not be required. One of the participants indicated that repeatability results greater 0.15 percent would be justification to run an additional test.

It was reported that more railroads are getting out of the testing business and that contract scale testing agencies are being used instead of the railroads. The testing agencies are charging more than the railroads. The additional charge is providing the belt scale owner added incentive to have an on-site scale. It should also be noted that the contract testing agencies may not have the suitable standards. Additionally, the contract agencies may not have access to the railroad master scales (and existing master scales are not always being replaced as they area taken out of service).

Many of the participants agreed with the alternate proposal of using a repeatability tolerance to determine if additional testing is required rather than taking enforcement action on only two test that are within belt-conveyor scale tolerances.

One more concern was raised with how the zero requirements may affect the repeatability and using up much of the scale's allowable error.

At the beginning of the seminar, Paul Chase, NTEP Belt-Conveyor Sector Chairman, indicated a possibility that materials tests may be shortened (this would have to be backed up with additional research and test data). With shortened material tests, it becomes easier to conduct additional tests and use lower capacity scales that can be tested to a greater certainty.

Because of energy shortages, belt scales will again have additional attention. Power companies that receive the coal affect millions of households and the interests of accuracy and repeatability become more important to buyers and sellers of coal.

SEMINAR CONCLUSION

The NIST Technical Adviser and the submitter thanked the Belt-Conveyor Scale Technical Seminar Participants and indicated that they will take the input to develop this item for submission to one of the regional weights and measures associations.

Additional Agenda Item 2

Amend NIST Handbook 44 Belt-Conveyor Scales Code Paragraphs **S. 1.5. Rate of Flow Indicators and Recorders** and **UR. 1. Use Requirements** to change the upper limit for the use and activation of the alarm to be 100 percent of scale capacity instead of 98 percent of scale capacity.

Problem

Mistakes may occur in calculation to determine weights associated with the 98% flow rates during filed inspections and type evaluations.

Justification

The original justification to limit flow rates to 98% of scale capacity was that analog chart recorders did not have a way to indicate flow rates above 100%. By setting the alarm to allow the operator to 98%, enough space would be still left on the chart recorder for flow rates within the capacity of the analog chart recorder.

With the advancement in rate of flow indicators and recorders, use of analog chart recorders is not as prevalent. Digital flow rate recorders can easily record flow rates exceeding 100%.

SEMINAR DISCUSSION

Many participants indicated that safety is a consideration for the limits. The 100% limit might be too late to warn the operator if the material may overflow the belt and may overload the belt drive and feeding mechanisms.

The manufacturers indicated that most of their customers do not operate belt-conveyors near full capacity and typically order scale rated 25% higher than their normal operating capacity for the above reasons.

SEMINAR CONCLUSION

The seminar participants agreed to leave the overload limits as they are currently written in NIST Handbook 44.

NIST/OWM Belt-Conveyor Scale Technical Seminar Participants

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Andrea P. Buie, Maryland Department of Agriculture

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Tina G. Butcher, NIST

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Rafael Jimenez, Association of American Railroads

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